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Witness Statement No.5
WOOD SUPPLY AND ENVIRONMENTAL IMPACTS OF TIMBER
MANAGEMENT, PART 1: MANAGEMENT ISSUES. / Benson,
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IN THE MATTER of the Environmental Assessment Act (R.S.O. 1980, c. 140) as amended; and

IN THE MATTER of a hearing before the Environmental Assessment Board regarding a Class Environmental Assessment for Timber Management on Crown Lands in Ontario.

WITNESS STATEMENT No. 5

WOOD SUPPLY AND ENVIRONMENTAL IMPACTS
OF TIMBER MANAGEMENT

PART 1: MANAGEMENT ISSUES

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FORESTS FOR TOMORROW

a coalition of

The Botany Conservation Group
of the University of Toronto

The Temiskaming Environmental
Action Committee

The Federation of Ontario
Naturalists

The Wildlands League, an Ontario
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SUMMARY

PART I. MANAGEMENT ISSUES

Chapter One. Sustained Yield and the Aim of the OMNR.

1. The aim of the OMNR is too general and obscure to fathom what is expected quantitatively for the forest industry or other users. Pages 2-4.

2. Sustained yield as construed by the OMNR means that future harvests will decline. Pages 5-10.

Chapter Two. Allowable Cut.

1. Determining the allowable cut by the OWOSFOP (MAD) method produces variable area and volumes of timber harvest every five year period. Pages 11-13.

2. The allowable cut volumes as determined with OWOSFOP fluctuate, and for most management units will decline as the older age-classes are harvested. Fluctuations are caused by the allowable cut formula, no immediate effect of regeneration on volume or area available, using a land base larger than the area that can be sustained, the variable species composition of stands is not accounted for beyond five years, rotations are lower than appropriate for the silviculture methods used, and the loss or gain

of land in a working group is not accounted for. Pages 14-38.

Chapter Three. Wood Supply.

1. Allowable cut versus depletion. Determination of the accrual and depletion of the timber resource on a regional or provincial basis is difficult because of the fluctuating OWOSFOP allowable cut values, management unit boundaries have changed, lack of records of the historical development of management units, lack of management plans, reticence of the OMNR to provide data, no summaries of data on a district, regional, or provincial basis, inadequate land and stand inventory. Pages 39-45.

2. Sustainable harvest compared to depletion. Present depletion exceeds accrual. Page 46,

3. Conclusions on wood supply. As long as depletion exceeds accrual, a gradual drop in timber supply will occur. Pages 47-51.

Chapter Four. Integrated Resource Management or Holistic Management.

1. Production of timber and other resources by the OMNR are not being optimized or maximized. Pages 52-54.

2. The expectations of users cannot be optimized unless the levels of production possible for a management unit are determined and recognized. Pages 55-56.

3. Managing for the future requires managing for all resources now. Page 57.

4. Four basic steps are required in the planning process to optimize the management of the forest resources for all users. Pages 58-63.

Chapter Five. Planned Natural Regeneration and Productivity.

1. Planned natural regeneration of the forest is sufficient to meet the production targets of 2020 if stands of comparable quality to existing stands are regenerated. Pages 64-76.

Chapter Six Planned Natural Regeneration and Economics.

1. Investing in intensive management is a social cost to the people of Ontario. Pages 77-80.

2. Natural regeneration is used in other parts of the world and Canada. Pages 81-82.

3. Economic analyses by the OMNR use value added to artificially inflate the end value of timber. No consistency occurs in their measuring of economic efficiency. The Forest Production Policy Options use value added, did not compare a natural regeneration option to the more expensive intensive options, and used a low, unrealistic rotation. Pages 83-99.

Chapter Seven. Ecological Reasons For Natural Regeneration.

A forester must use general principles to manage a forest to

retain site productivity and species diversity.

1. Successful regeneration of a forest requires the creation of site conditions favourable to desired species. Modified harvest methods for natural regeneration can create the site conditions, emulate the mosaic pattern that follows a fire in the boreal forest, and ensure that a seed source is within seeding distance of the harvested area. The use of large clearcuts and intensive silviculture has not been successful. The smaller cut areas of modified harvesting can be successfully used. Limits on the size of clearcuts are used in other provinces of Canada, in the United States and Europe. Pages 102-116.

2. Water. Modified harvest areas reduce the area cleared of vegetation at any one time, thus provide more buffering of the detrimental effects of larger clearcuts on the quality and quantity of water. Pages 117-118.

3. Wind. The damaging effect of wind on the site and the forest can be reduced by implementing the smaller cuts of modified harvest methods. Pages 119-121.

4. Species Diversity. Silviculture can increase or decrease the diversity of an area, if it is designed to do so. The silviculture ground rules of normal and areas of concern are too vague to determine what their effect on species diversity will be. Legislated standards for maintaining and improving the diversity of life forms in the forest are non-existent in Ontario. Pages 122-129.

5. Wildlife. Management for wildlife suffers from the lack of inventories, habitat requirements of species, universal application of moose guidelines, no consideration for the development of habitat in the long term, The questionable long

term value of corridors, and no consideration of the edge effect. Modified harvesting for natural regeneration can be used to ameliorate the above problems. Pages 130-133.

6. Site Conditions. Sites in the boreal forest vary within a small area. The smaller cuts of modified harvesting for natural regeneration provide a better opportunity for specific sites to regenerate to the original species. Pages 134-136.

7. Site Damage. In Ontario, the amount of specific site damage by harvesting is not known, but it is known that the damaging effects are more drastic on shallow and organic soils, and where full tree harvesting is employed. The smaller cuts of modified harvesting can reduce and ameliorate the site damage more than larger clearcuts. Pages 137-146

Chapter Eight. Holistic Planning.

Planning for a forest for all life forms requires as a minimum the balancing of the age-classes, spatial heterogeneity, and a variety of forest types. Pages 147-153.

PART II MANAGEMENT PLANS

Overview of Management Plans.

1. The procedures used to examine management plan documentation and field procedures. Pages 155-157.
2. Features of the management plan are summarized. The

main points are allowable cuts are too high for sustained yield, the gradual elimination of older age-classes, large cutovers, small reserves, garbage in areas, vague silvicultural guidelines, lack of economic analyses, site damage, poor road quality, and no provision for preserving or increasing the diversity required for all life forms is being provided in long-term planning. Pages 158-166.

Chapters A to R.

Features of management plans evaluated were the allowable cut, silvicultural prescriptions, cutover, regeneration and cutover comparison, and detrimental management features. Pages 167-414.

Prof. Crandall Benson will attend the hearing and give evidence regarding the subject of this Statement of Evidence.

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I

MANAGEMENT ISSUES



1. SUSTAINED YIELD AND THE AIM OF THE OMNR.

Two of the most important issues of the undertaking are:

1. the aim of the Ontario Ministry of Natural Resources (OMNR) and,
2. the practical meaning of sustained yield.

Some confusion exists not only with the stated aim of the OMNR in managing the forest of Ontario and in the interpretations of sustained yield, but also with the relationship between the two.

1. The Aim

For the area of the undertaking, the aim is defined as "to provide a continuous and predictable supply of wood for Ontario's forest products industry". On the other hand, the Timber Management Planning Manual (TMP) for Ontario¹ states the:

1. **OMNR 1986.** Timber management planning manual for Crown lands in Ontario. (revised to 15 Feb 1988). Ont. Min. Nat. Resour., Toronto, Ont. 217 pp.

"objective of the forest management planning program on Crown land in Ontario is 'to provide for an optimum continuous contribution to the economy by forest-based industries consistent with sound environmental practices and to provide for other uses of the forest.' "

The omission of two items from the definition of the aim used for the class environmental assessment of the area of the undertaking has caused some of the perplexity surrounding the intention of the OMNR. The exclusion of these two items; the management of the forest for other uses and for sound environmental practices have obfuscated for participants in the environmental hearing the intent of the OMNR. In addition, it is neither clear as to what the amount of the "optimum continuous contribution" is expected to be, nor what the level of provision is to be for other users of the forest.

Obscurity in an aim makes it difficult to determine if a plan of action has been successful, but it does allow the manager a great deal of flexibility in the actions taken; although these actions may not be the intent of the aim.² An aim that includes the statement "to provide for other uses of the forest" can only be interpreted as a motherhood statement, as it gives no direction as to either the nature or the level to be provided for other uses. It is similar to a job description of "and other related duties". Translation of such a broad aim to implementation at the management unit level provides extreme latitude in implementing a variety of efforts that will lead to a spectrum of results that may or may not satisfy the intent of the aim.

Management of forests can have more specific aims. For

2. **Hummel, F. C. 1969.** Technical and financial planning in forestry. an H.R. MacMillan Lectureship, University of British Columbia, Vancouver, B.C. 12 pp.

example, the aim of the U.S. Forest Service on their federal forest lands is to:

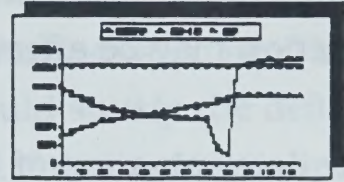
“provide the greatest long term net public benefits in an environmentally sound manner”.³

The maximization of long term benefits was further defined as:

“an expression used to signify the overall long-term value to the nation of all outputs and positive effects (benefits) less all associated inputs and negative effects (costs) whether they can be valued or not. Net public benefits are measured by both quantitative and qualitative criteria rather than a single measure or index.”⁴

This aim provides a clearer expression for devising and implementing management plans to achieve definite targets than the Ontario one. More important, the U.S. aim attempts to satisfy all public demands on the forest; not just the demand for timber products.

3. **USDA Forest Service 1985.** Draft environmental impact statement land and resource management plan. Superior National Forest. U.S. Forest Service, Duluth, Minn. 7 separately paginated chapters + appendices.
4. **Teeguarden, D. E. 1987.** Benefit-cost analysis in national forest system planning: policy, uses, and limitations. *Environ. Law*, 17:393—427.



2. Sustained Yield

A second point of confusion is the enigma of what does the OMNR mean by sustained yield. Sustained yield has been interpreted as having a theoretical and practical meaning.⁵ More important is a recognition of the maximum sustainable harvest from a forest. The maximum sustainable harvest limits the amount of wood that can be expected from a management area. If more than the maximum sustainable harvest is taken consistently from a forest, two things may happen:⁶

- a). Mills will have to reduce their supply from the forest and close some of their facilities.
- b). Total depletion of the forest will occur.

A recognition of the practical limitation of the capability of a forest to produce a certain amount of wood is necessary in order to achieve the aim of management and sustained yield. At the same time, it must be recognized that a forest also has a limit for producing other resources. As the production of the various

5. OMNR 1989. Panel III: Statement of evidence. The Basis For Wood Supply Planning, Environ. Assess. Hearings, Thunder Bay, Ont. pp. 21—22.
6. Clutter, J. L., J. C. Fortson, L. V. Pienaar, G. H. Brister, R. L. Bailey 1983. Timber management a quantitative approach. John Wiley & Sons, Toronto. 333 pp.

renewable resources from the forest may either conflict or compliment one another, the practical limitation of timber production may be affected by the need to produce other resources.

The determination of the sustainable yield for a forest is relatively simple.^{7,8} In a fully regulated forest, it is calculated by the following formula:

$$\text{LTSY} = \text{MAI} \times A$$

Where LTSY is the long term sustainable yield or the maximum that can be harvested in perpetuity, MAI is the mean annual increment, and A is the productive area of the forest. MAI is determined by dividing the yield at harvest from a stand by the number of years of growth of that stand.

Harvesting the LTSY in a fully regulated forest is a perpetual harvest that annually harvests an amount equal to the growth. In a forest that is not fully regulated, a volume lower than the LTSY may need to be harvested. Harvesting of the LTSY in a forest not fully regulated may lead to one of the following results:

- a). A fully regulated forest will develop.
- b). The forest will be depleted.

Harvesting significantly less than the LTSY will cause the average age of the forest to increase to the point where it may be

7. **Davis, L. S. and K. N. Johnson 1987.** Forest management. Mc-Graw-Hill Book Co., Toronto. Ont. 790 pp. (Excerpts are included in exhibits 106 and 134.)
8. **Clutter, J. L., J. C. Fortson, L. V. Pienaar, G. H. Brister, R. L. Bailey 1983.** Timber management a quantitative approach. John Wiley & Sons, Toronto. 333 pp.

considered unmanaged.⁹

The level of harvest of a forest that leads to the development of a fully regulated forest at any point in time may be calculated by the LTSY method. Use of the LTSY method would satisfy the definition of sustained yield in the Crown Timber Act,¹⁰ where it is defined as:

"the growth of timber that a forest can produce and that can be cut to achieve a continuous approximate balance between growth of timber and timber cut."

This above definition of sustained yield is used in the TMP. Although the definition of sustained yield appears straightforward, the OMNR interpreted sustained yield by stating:

"the practical meaning of sustained yield is the application of management to provide for 'continuity of harvest', and this is what the term means for timber management in Ontario and, indeed, in Canada."¹¹

Continuity of harvest is being used as the definition of sustained yield in the OMNR Districts.¹² Only part of the Davis 1966¹³ definition of sustained yield is favoured and practiced by the OMNR, instead of the CTA definition.¹⁴ The part of the definition

9. Clutter, J. L., J. C. Fortson, L. V. Pienaar, G. H. Brister, R. L. Bailey 1983. Timber management a quantitative approach. John Wiley & Sons, Toronto. 333 pp.
10. Government of Ontario 1987. Crown Timber Act. Queen's Printer, Toronto, Ont. 53 pp. (Exhibit 110.)
11. OMNR 1989. Statement of evidence: Panel III. The basis for wood supply planning. Toronto, Ont. 264 pp.
12. OMNR 1988. Brief to the Temagami Working Group. Ont. Min. Nat. Resour., Toronto, Ont. 102 pp.
13. Davis, K. P. 1966. Forest management. McGraw-Hill, Toronto, Ont. 519 pp. (Excerpts are in exhibit 105).
14. OMNR 1989. Statement of evidence: Panel III. The basis for wood supply planning. Toronto, Ont. 264 pp.

preferred is:

"whether reckoned by years or by longer periods, the purpose is to obtain a sustained flow of products, a flow that may be currently increased or diminished in accordance with the purpose of management and the condition of the forest, but which may be continued indefinitely though often at variable levels."

The remainder of the description of sustained yield not used by the OMNR is:

"The whole body of forest regulatory techniques is aimed at organization of a forest to bring about this sustained yield of harvested products in an efficient and orderly manner. Current harvest does not necessarily equal current growth, but in the long run and on the average it must."¹⁵

The most important part of the Davis definition omitted by the OMNR was that the average harvest of the forest must equal the growth of the forest in the long run.

More recent definitions of sustained yield refer to a harvest that equals growth in the long term. For example, Davis *et al.*¹⁶ describe sustained yield as:

"In general, the maximum that a forest can yield at any time is the growth that has accumulated up to that time, and the maximum yield that can be removed perpetually per period equals the growth per period."

15. Davis, K. P. 1966. Forest management. McGraw-Hill, Toronto, Ont. p. 8. (Excerpts are in exhibit 105.)

16. Davis, L. S. and K. N. Johnson 1987. Forest management. Mc-Graw-Hill Book Co., Toronto, Ont. 790 pp. (Excerpts are included in exhibits 106 and 134.)

In the Terminology of Forest Science,¹⁷ sustained yield is defined as:

"The yield that a forest can produce continuously at a given intensity of management. NOTE: Sustained-yield management therefore implies continuous production so planned as to achieve at the earliest practical time a balance between increment and cutting."

The US Forest Service has taken the definition of sustained yield one step further and uses a non-declining sustained yield:

"where the harvest in any year must be greater than or equal to the harvest for the preceding year."¹⁸

Industry provided a definition of "sustainable basis of wood supply" that is similar to the OMNR's definition:

"dedicated forest land which will be managed and renewed to provide a continuous flow of timber to the forest industry."¹⁹

Another definition of the industry appears to favour the traditional and CTA definition of sustained yield:

"We define 'sustainable harvest' as the annual harvest which does not exceed the annual growth by working group."²⁰

17. **SAP 1983.** Terminology of forest science technology practice and products. Society of American Foresters, Washington, D.C. 370 pp.
18. **Clutter, J. L., J. C. Fortson, L. V. Pienaar, G. H. Brister, R. L. Bailey 1983.** Timber management a quantitative approach. John Wiley & Sons, Toronto. 333 pp.
19. **OFIA/OLMA 1989a.** Answer to interrogatory question #1 of Forest for Tomorrow for OFIA/OLMA Panels I and II.
20. **OFIA/OLMA 1989b.** Answer to interrogatory question #1 of Forest for Tomorrow for OFIA/OLMA Panels I and II.

What has not been adequately explained by the OMNR at the hearings is the core of sustained yield; will the future harvests of timber be lower or higher than the current ones? A major factor affecting future wood supplies is the rate of depletion, the maximum allowable depletion (MAD) allowable cut, that is used at the present time.

2. ALLOWABLE CUT.

1. Determining the Allowable Cut

The OWOSFOP²¹ method of determining the allowable cut is a weighted area method. It is not a sustainable method of determining the allowable cut.^{22,23} A weighted area method of determining the allowable cut may be used to reduce the amount of overmature timber, but it is usually applied to ensure that the timber production does not fall below the production of a regulated forest.²⁴ Volumes associated with the area allocated will vary for the 5-year periods unless the forest has a fully regulated age-class distribution. This variation in the allowable cut volumes as determined by the weighted area method has caused confusion

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21. OWOSFOP was the only method for determining the allowable cut for the even-aged management of forests from 1979—1987. The details of the OWOSFOP calculation have varied since its inception, but the overall effects are as outlined in this chapter. In 1987, other methods could be used if they were justified. Justification is based on how the different methods vary from the criteria used in the OWOSFOP model, rather than on achieving the sustained yield objective. Only 14% of the productive forest land of Ontario is classed as overmature (Bonner 1982).
 22. **Woodbridge, Reed and Associates 1987.** A study of Ontario forest products industry. Prepared for Forest Resources Group OMNR. 96 pp. (Exhibit 61.)
 23. **Tworzyanski, T. 1987.** Annual cut versus forest depletion: Ontario's approach to wood supply analysis. Canadian Forest Industries, Sep. pp. 565—569.
 24. **Buongiorno, J., and J. K. Gilless 1987.** Forest management and economics. MacMillan Publishing Company, New York. 285 pp.

between the industry and the OMNR.^{25,26} Volumes are determined from the area allocated for a five-year period, first from the Forest Resources Inventory (FRI) and then by operational cruising or modifications to the FRI, or a combination of the two inventories.^{27,28} The estimated volumes are reduced by extracting areas that have species with no market, areas that are complete or partial reserves, and for areas that are inoperable.²⁹ The remaining volume is assigned to the timber operators, while the timber that is not to be harvested is "surplus". In effect, if it cannot or is not to be harvested, it should not be included in the land base at the start of the calculation. This additional land base merely inflates the initial allowable cut calculations. If the reserves are kept in the land base with no intent to harvest them, the allowable cut is an

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25. **Baskerville, G. L. 1986.** An audit of management of the Crown forest of Ontario. OMNR, Toronto, Ont. 97 pp. (Exhibit 16.)
 26. **Innes, M. R. 1984.** The road to success is always under construction. Paper presented at the 65th annual meeting of the Woodlands Section of the CPPA. WSI 2914 (F-2) ODC 903 (713).
 27. **OMNR 1986.** Timber management planning manual for Crown lands in Ontario. (revised to 15 Feb 1988). Ont. Min. Nat. Resour., Toronto, Ont. 217 pp.
 28. **OMNR 1989.** Red Lake Crown management unit timber management plan excerpts. OMNR Reference No. 3A of Panel XV for the Class Environmental Assessment for Timber Management on Crown Lands in Ontario, Ont. Min. Nat. Resour., Toronto, Ont. 145 pp. (Exhibit 818.)
 29. **OMNR 1989.** Red Lake Crown management unit timber management plan excerpts. OMNR Reference No. 3A of Panel XV for the Class Environmental Assessment for Timber Management on Crown Lands in Ontario, Ont. Min. Nat. Resour., Toronto, Ont. 145 pp. (Exhibit 818.)

overestimate of the wood supply available.³⁰ In addition, if the reserves are in the older age-classes they have the effect of artificially increasing the allowable cut above what can realistically be sustained both in area and volume. The effect is that the areas allocated in five year periods will vary because of the technical nature of the allowable cut calculation, and because of the variable amounts of area and volume that may be subtracted every five-year period.

The effect of including 'additional' land in the productive forest land base may be illustrated by considering a forest of 10 000 ha with a rotation period of 100 years, and assuming the free-to-grow period is the same as the rotation period). If this forest has a normal distribution of age-classes, the normal annual allowable cut would be $10\,000 \div 100 = 100$ ha per year (10 000 ha divided by the 100 year rotation). The weighting factor would be equal to 1, as the average age of the normal forest would be the same as the average age of this theoretical forest ($50 \div 50 = 1$; the average age of the forest divided by the average age of the normal forest). If 1 000 ha of this forest is actually reserves that will never be cut, the allowable cut, without considering the weighting factor, would be $9\,000 \div 100 = 90$ ha per year (10 000 ha minus the 1 000 ha of reserves = 9 000 ha of productive forest)

However, the weighting factor would change from 1, if the reserves were not equally distributed among all age-classes. If the 1 000 ha of reserves were in the 80—100 age class, the oldest age-

30. **Baskerville, G. L. 1986.** An audit of management of the Crown forest of Ontario. OMNR. Toronto, Ont. 97 pp. (Exhibit 16.)

class of this forest, the weighting factor would be reduced to 0.911. The weighted area allowable cut would be $0.911 \times 90 = 82$ ha per year (weighting factor of 0.911 times the normal area of 90). The difference in the annual allowable cut for this theoretical forest would be $100 - 82 = 18$ ha per year (100 ha annual allowable cut of the normal forest including the reserves in the calculation minus the 82 ha annual allowable cut determined when the reserve area is subtracted from the productive forest land base and the weighting factor is adjusted to reflect the changes in the age-class structure).

2. OWOSFOP Volume Fluctuations

A number of factors of the OWOSFOP calculation cause variation over time in the volumes that may be expected are listed below:

a). Volumes that may be expected to be harvested vary over time. When applied to a forest with a preponderance of older age-classes, the calculated allowable cut will start high, decline, and then rise before levelling off. Volume determinations are imprecise for both the present, and the new forest, whether the new forest is natural or a plantation.

b). Regeneration does not have an immediate effect on the volume available.

c). The productive land base used for the maximum allowable

depletion (MAD) calculation includes reserve areas, losses to fire, insects and diseases. This produces an initial allowable cut calculation that exceeds the actual productive capability of the land to sustain.

d). The volume per hectare of a species within a working group can vary because of the percentage composition of that species in the stand.

e). Rotations are based on regenerating the forest artificially, although the majority of the forest land regenerates naturally. Without using the longer rotation usually required for natural regeneration, the shorter rotations cause an increase in the initial allowable cut.

f). The OWOSFOP method of determining the allowable cut accounts for land lost to a working group because of the inability to regenerate it or for other losses such as landings and roads. The land lost may regenerate to another working group, but usually OWOSFOP does not take the land gained by a working group into account.

The above points can be illustrated by the using the information on the spruce working group of Ontario.³¹ The net merchantable MAI for the spruce working group, as determined from the inventory information, provides information on the volumes available. A rotation of 90 years was used for the OWOSFOP

31. OMNR 1986. The forest resources of Ontario. Ont. Min. Nat. Resour., Toronto, Ontario. 110 pp. (Exhibit 56.)

method, and the net merchantable MAI at an age of 90 years was used for the sustained volume method (see Figure 2 — 1 on page 22). The LTSY for the spruce working group of Ontario is calculated as $1.3729 \times 157684074 = 21.7$ million cubic metres. (MAI at rotation age of 90 multiplied by the productive land base). For five years, the LTSY would be 108 million cubic metres. If a higher rotation is required the sustainable yield would be lower.

a). For the first point, the expected allowable cuts of the OWOSFOP and a sustained yield method are demonstrated (see Figure 2 — 2, page 23). Both methods assume that all land is regenerated to stands equal in productivity as those harvested. One can clearly see the decline in the volumes of spruce that would be available; from 180 million to less than 80 million cubic metres in a period of 65 years. On the other hand, the sustainable yield method allows a continuous volume of 80 million cubic metres to be harvested on a sustainable basis. The predicted areas that could be harvested by each method also varies, (see Figure 2 — 3 on page 24). With the OWOSFOP method, more area is harvested in the initial years. In addition to the decline in future volumes to be expected from the OWOSFOP method, harvesting would occur in the 61—80 age-class, below the desired rotation age (see Figure 2 — 4 on page 25). If harvesting the age class 61—80 is not feasible, the cut would fall to almost zero (see Figure 2 — 5 on page 26). Similarly, some harvesting would occur below the 81—100 age-class using the sustained method (see Figure 2 — 6 on page 27).

If no harvesting is desired in the 61—80 age-class, the level of harvest must be lower. For example, if the MAI at a rotation age of 105 years, instead of 90 years, is used to determine the LTSY, harvesting of the 61-80 age class is eliminated (see Figure 2 — 7 on page 28).

Two additional indicators of the development of the forest are the curves of the growing stock and the increment. The OWOSFOP method produces more fluctuation in these two curves than the sustained yield method (see Figure 2 — 8 on page 29 and see Figure 2 — 9 on page 30). A smoother stabilization of these two curves indicates a more stable transition to the more regulated forest.

b). To illustrate that regeneration efforts do not have an immediate effect on the OWOSFOP determined allowable cut, it was assumed that the yield of the future spruce working group would be double the present yield. As can be seen in (see Figure 2 — 10 on page 31), the increase in future volumes available does not occur until 70 years into the future. This is presuming that the 61—80 age-class can be harvested and that future yields can be doubled.

Lack of regeneration effort has no appreciable affect on the volumes available for harvest during a time period equal to the sum of the delay and establishment periods. If it is assumed that no regeneration occurs, the volumes expected to be available for

harvest by using various delay and establishment periods are shown in Figure 2 — 11 on page 32.

Increasing the length of the delay period causes an increase in the allowable cut and results in a wider variation in the highest and lowest volumes expected (see Figure 2 — 12 on page 33). This presumes that harvesting can occur in the younger age classes. For example, with a delay and establishment period of 15 years each, the future expected harvest would occur in the 41—60 age-class (see Figure 2 — 13 on page 34).

c). The effect of reducing the productive land on the OWOSFOP allowable cut calculation for the spruce working group is shown in Figure 2 — 14 on page 35. A reduction of 30%³² was used to account for fire, insect, and disease losses, and reserves. The common procedure for determining the allowable cut is to use only the productive land base for determining the allowable cut.^{33,34} This requires identification of the productive land base prior to the calculation. The OMNR management procedure is the reverse of this and identifies the land use after the initial allocation.

d). The effect of not considering the species composition of a working group is shown in Figure 2 — 15 on page 36. This figure is

32. van Frassen, A. M. 1982. The effect of the spruce budworm problem on policy and planning. in *The Spruce Budworm Problem In Ontario--Real Or Imaginary?*, COJFRC Symposium Proceedings O-P-11. Can. For. Serv., Sault Ste. Marie, Ontario. pp. 57—60.

33. Clutter, J. L., J. C. Fortson, L. V. Pienaar, G. H. Brister, R. L. Bailey 1983. *Timber management a quantitative approach*. John Wiley & Sons, Toronto. 333 pp.

34. Johnston, D.R., A. J. Grayson and R. T. Bradley 1967. *Forest planning*. Faber and Faber Ltd., London. 541 pp.

composed of data from the Temagami Management Plan for the period 1980—1990.³⁵ The majority of the cut of white pine comes from other than the white pine working group. A more sophisticated method of determining allowable cuts would allow the volume of a species available from all working groups to be determined. It would require a more accurate inventory system than presently used, as neither the Forest Resources Inventory (FRI) or the operational cruising can be related to the actual scaled volumes.³⁶ Without an accurate assessment of the scaled volumes that may be expected from the operational areas of a management unit, no reliable estimates of wood supply may be made at the operational level of management plans. Wood supply estimates at the District, Regional and Provincial level are also questionable because of the inventory problems and by not determining the volumes of a species within a working group.

f). When longer rotations are used to more realistically account for the fact that the majority of the regeneration is by natural regeneration (the Delay period is longer), the allowable cut as determined by the OWOSFOP method increases rather than decreases the initial determination of the allowable cut (see Figure 2 — 12 on page 33). The difference between the OWOSFOP and sustained yield cut is greater than before (Compare Figure 2 — 2 on page 23 to Figure 2 — 12 on page 33).

35. **OMNR 1985.** Forest management plan for the Temagami Crown Management Unit. Ont. Min. Nat. Resour., Temagami, Ontario. 213 pp.

36. **Rosehart, R. 1987.** An assessment of Ontario's forest resources inventory system and recommendations for its improvement. Prepared for the Ont. Min. Nat. Resour. by The Ontario Forest Resources Inventory Committee. OMNR, Toronto, Ont. 45 pp. (Exhibit 93.)

g). Without taking into account the increase in the land base for area that may be transferred from another working group, the future allowable cuts are underestimated. For example, if it is assumed that the spruce working group productive land base increases by 5% each year, the sustainable allowable cut would gradually increase (see Figure 2 — 16 on page 37).

If some of the above factors are considered; the longer rotation required for natural regeneration, 70% of the spruce working group is actually spruce, and a 30% loss of the land base; the sustainable harvest would be considerably less than without considering these factors (see Figure 2 — 17 on page 38).

The above points illustrate the problems the OMNR has in:

a). Trying to achieve a sustained yield by the conventional definition).

b). Knowing what the future timber production will be.

3. Volume Information

Complicating the problem of determining the allowable cut by any method, are the estimates of volume available. Although Table 4.17 of the Timber Management Plan³⁷ indicates volumes that are to be harvested, it is actually only an estimate. Neither the FRI or the operational cruising can be related to the actual scaled

37. OMNR 1986. Timber management planning manual for Crown lands in Ontario. (revised to 15 Feb 1988). Ont. Min. Nat. Resour., Toronto, Ont. 217 pp.

volumes.³⁸ Without an accurate assessment of the scaled volumes that may be expected from the operational areas of a management unit, no reliable estimates of wood supply may be made at the operational level of management planning. Thus, the wood supply to an industry from a management unit is not predictable. The necessity for linking the area and volume harvested was noted by Baskerville^{39,40}

A historical record of scaled wood volume from an management unit could approximate the yield expected. If the scaled volume data is recorded by site types a closer approximation could be attained. Management plans do not contain this data, except for the previous five years in the new plans. The only region that has recorded estimates of the yield is the Northeastern Region.⁴¹ This data could be applied to management units in that region to determine the sustainable harvests, but this is not recorded as being done.

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38. **Rosehart, R. 1987.** An assessment of Ontario's forest resources inventory system and recommendations for its improvement. Prepared for the Ont. Min. Nat. Resour. by The Ontario Forest Resources Inventory Committee. OMNR, Toronto, Ont. 45 pp.
39. **Baskerville, G. L. 1986.** An audit of management of the Crown forest of Ontario. OMNR, Toronto, Ont. 97 pp. (Exhibit 16.)
40. **Transcripts 1989.** Environmental Assessment Hearings, Toronto, Ontario pp. ccc-ccc.
41. **OMNR n.d.** Yield tables for the major working groups and site regions of the Northeastern Region, Sudbury, Ontario. Separate non-paginated pages for each working group.

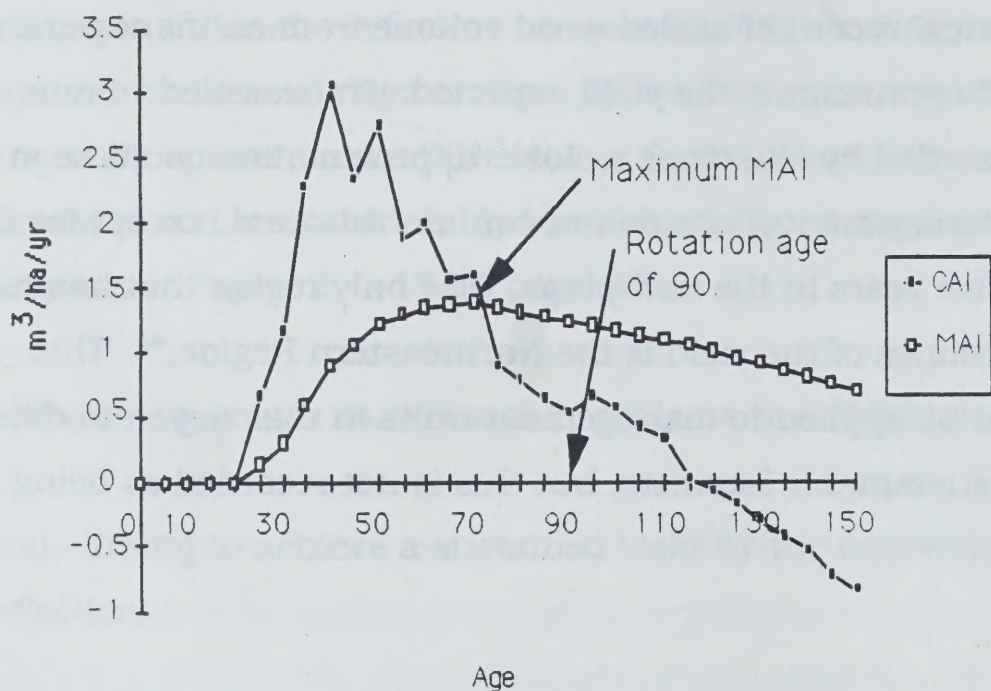


Figure 2—1. Net merchantable CAI and MAI for the spruce working group of Ontario.

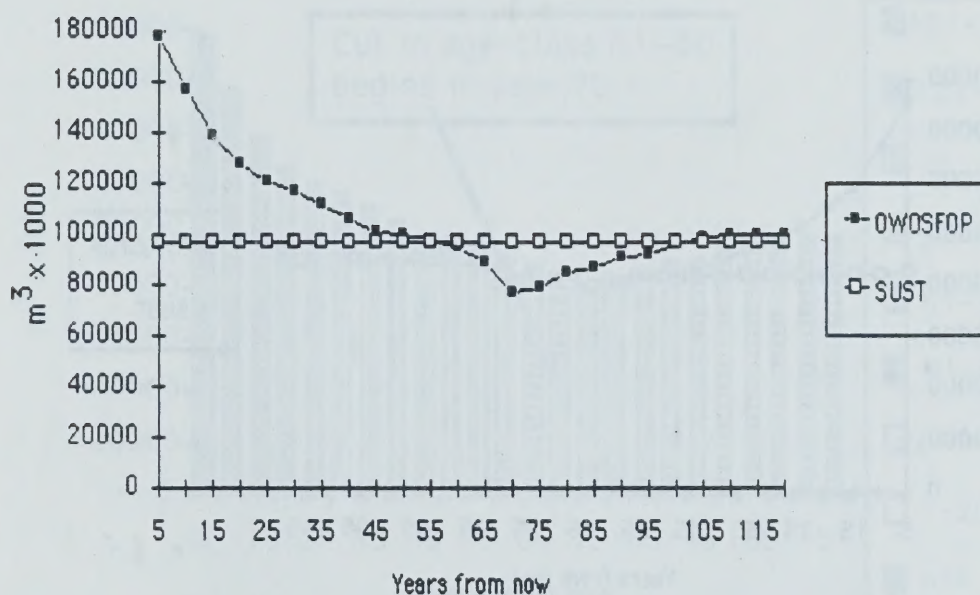


Figure 2—2. Projected five-year allowable cut volumes for the spruce working group of Ontario by the OWOSFOP and sustained yield (Sus) methods. For this example, both methods assume that harvesting of the 61—80 age-class will be feasible in the future.

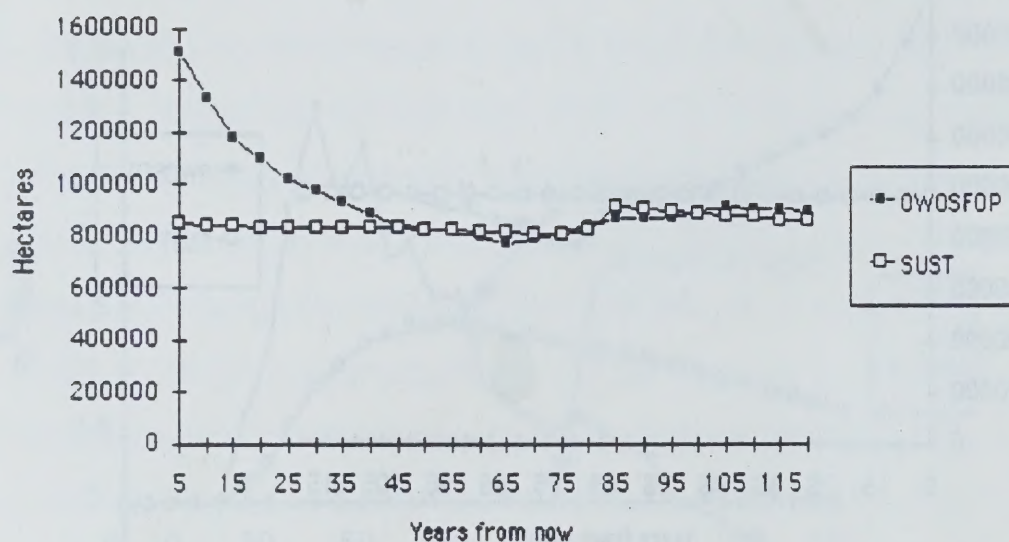


Figure 2—3. Predicted five-year allowable cut areas for the spruce working group of Ontario by the OWOSFOP and sustained yield (Sus) methods. For this example, both methods assume that harvesting of the 61—80 age-class will be feasible in the future.

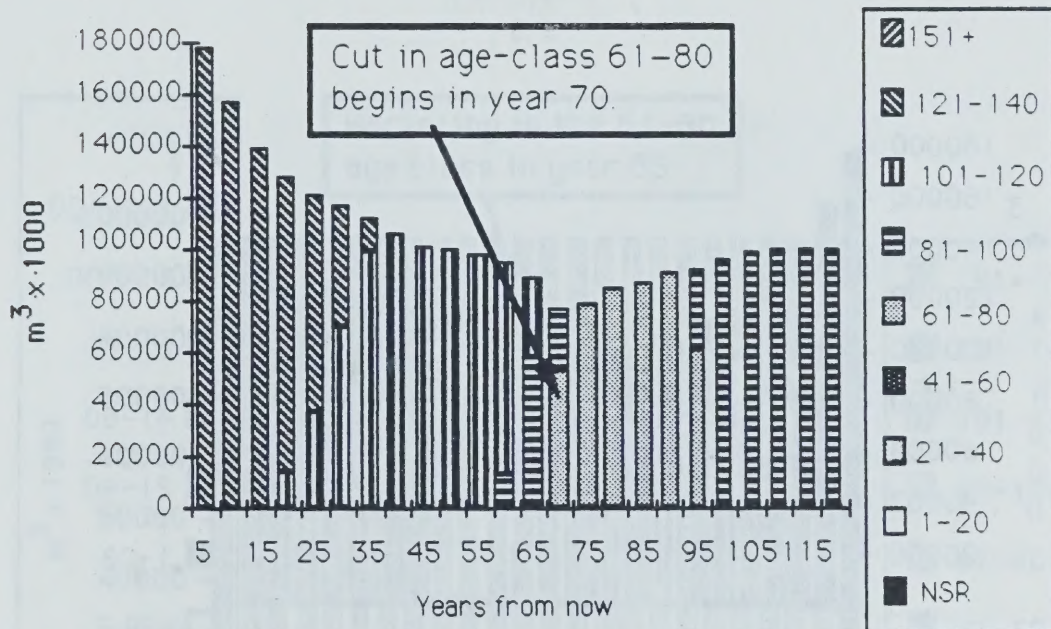


Figure 2—4. Five-year volume predictions to be harvested by age-class using the OWOSFOP method. Expected age-class of harvest volume is indicated.

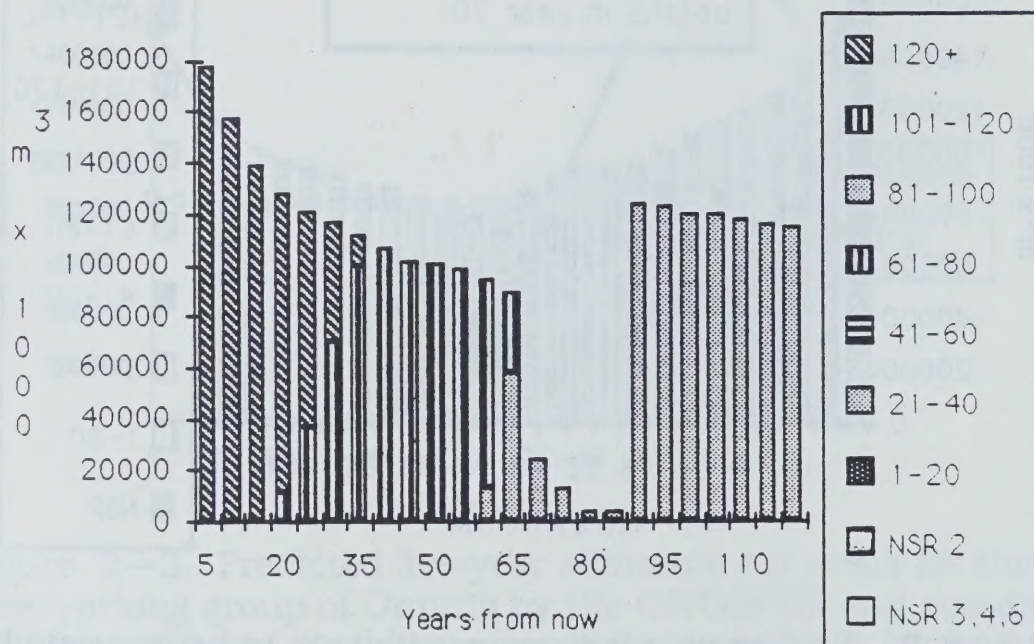


Figure 2—5. Five-year volume predictions to be harvested by age-class using the OWOSFOP method with no harvest of the 61-80 age-class occurring. Expected age-class of harvest volume is indicated. The initially high allowable cut drops to almost zero in 80 years.

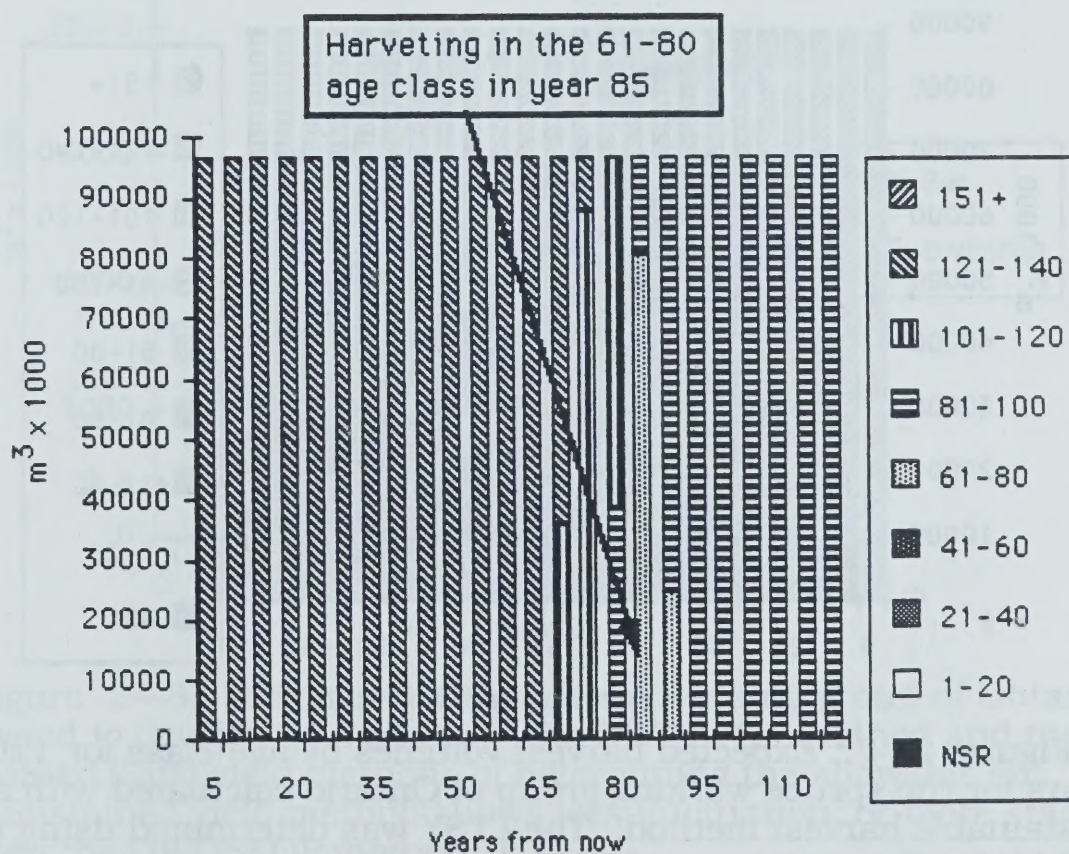


Figure 2—6. Expected harvest volumes of the spruce working group of Ontario, by age-class for 120 years. A sustainable method of calculating the allowable cut was used. The LTSY was determined using the NM MAI at a rotation age of 90 years.

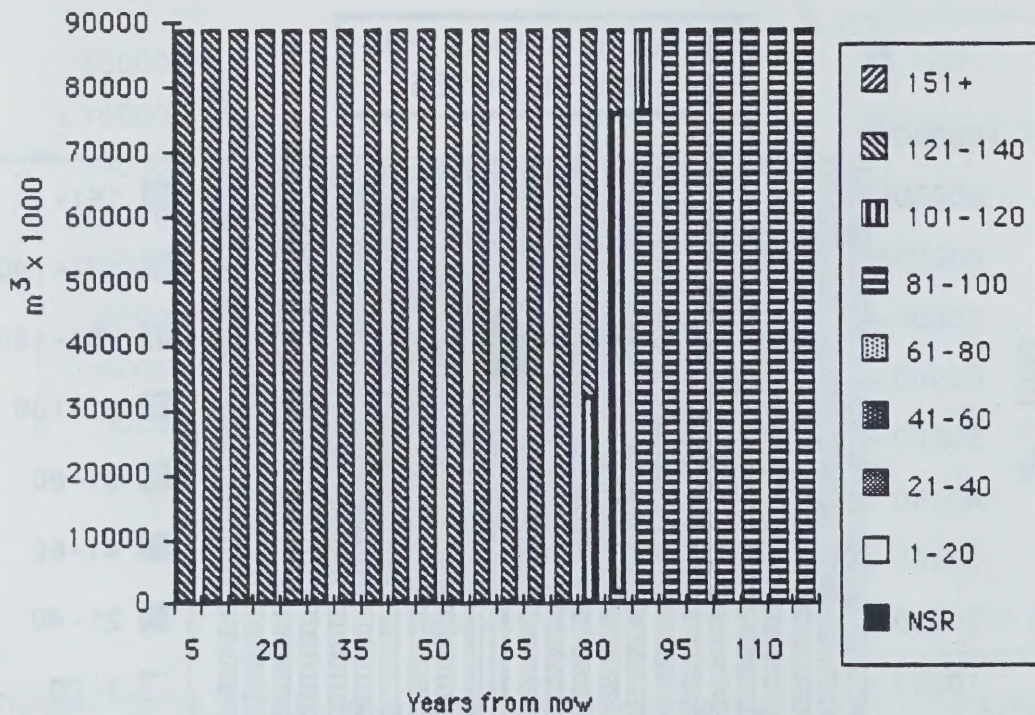


Figure 2—7. Expected harvest volumes by age-class for 120 years for the spruce working group of Ontario calculated with a sustainable harvest method. The LTSY was determined using the NM MAI at a rotation age of 150 years. No harvesting occurred in the 61—80 age-class.

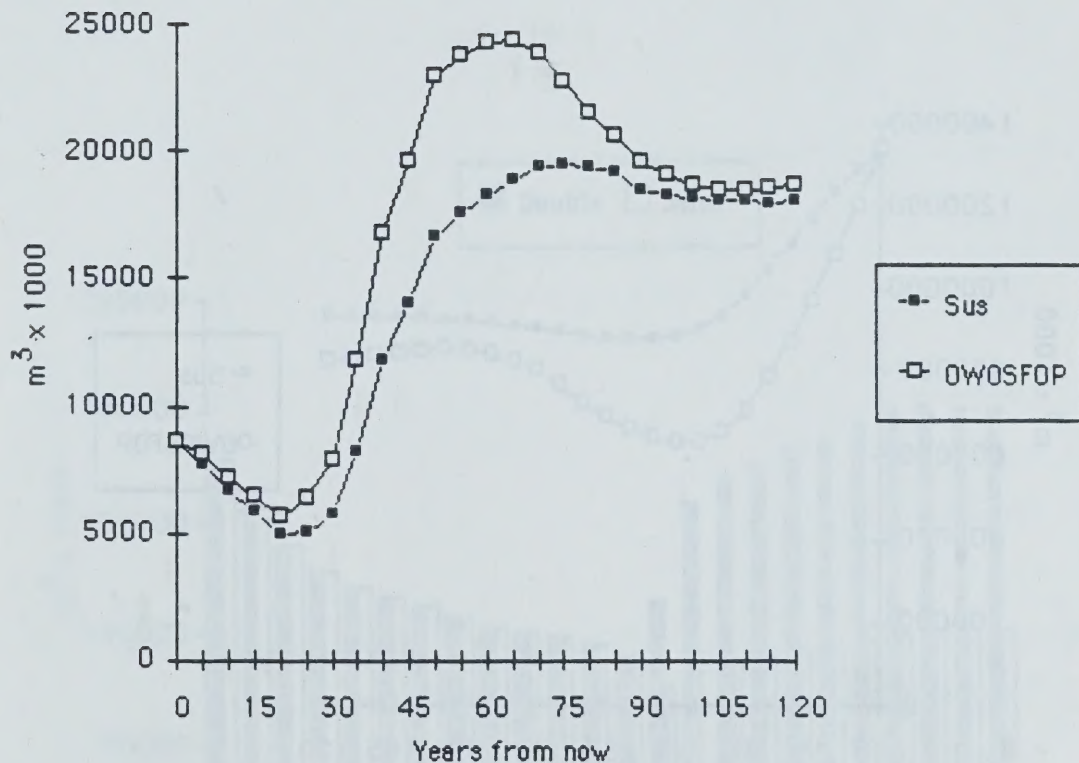


Figure 2—8. Increment of the spruce working group of Ontario expected to develop as a result of the OWOSFOP method and the sustained (Sus) yield methods of determining the allowable cut. The Sustained yield method shows less fluctuation, or more stability than the OWOSFOP method.

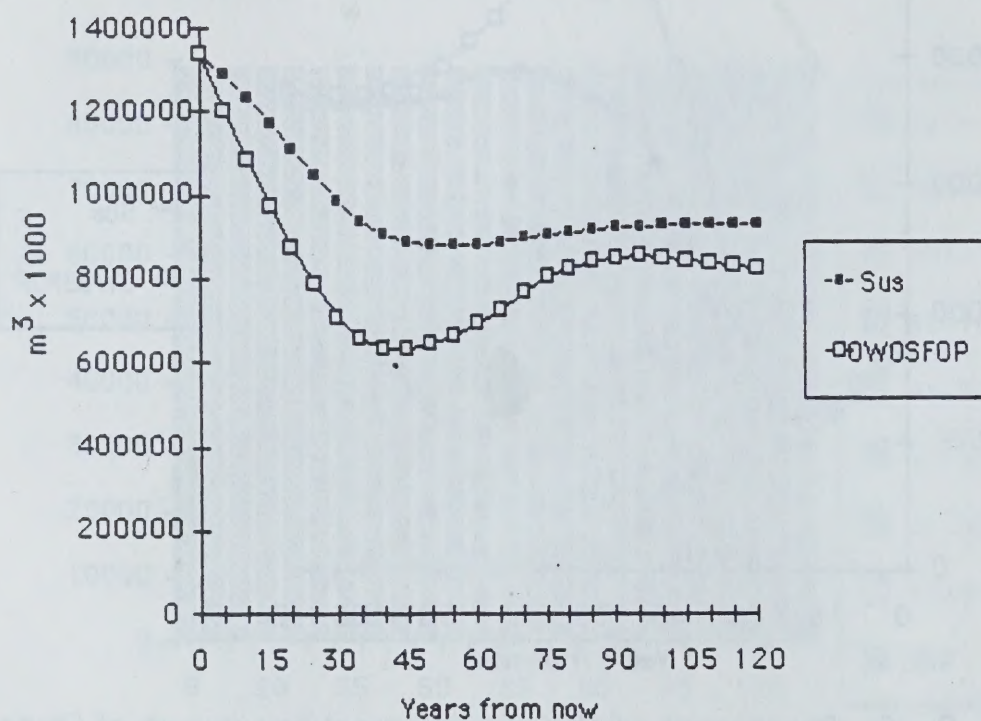


Figure 2—9. Growing stock of the spruce working group of Ontario expected to develop as a result of the OWOSFOP and sustained (Sus) yield methods of determining the allowable cut. The Sustained yield method shows less fluctuation, or more stability than the OWOSFOP method.

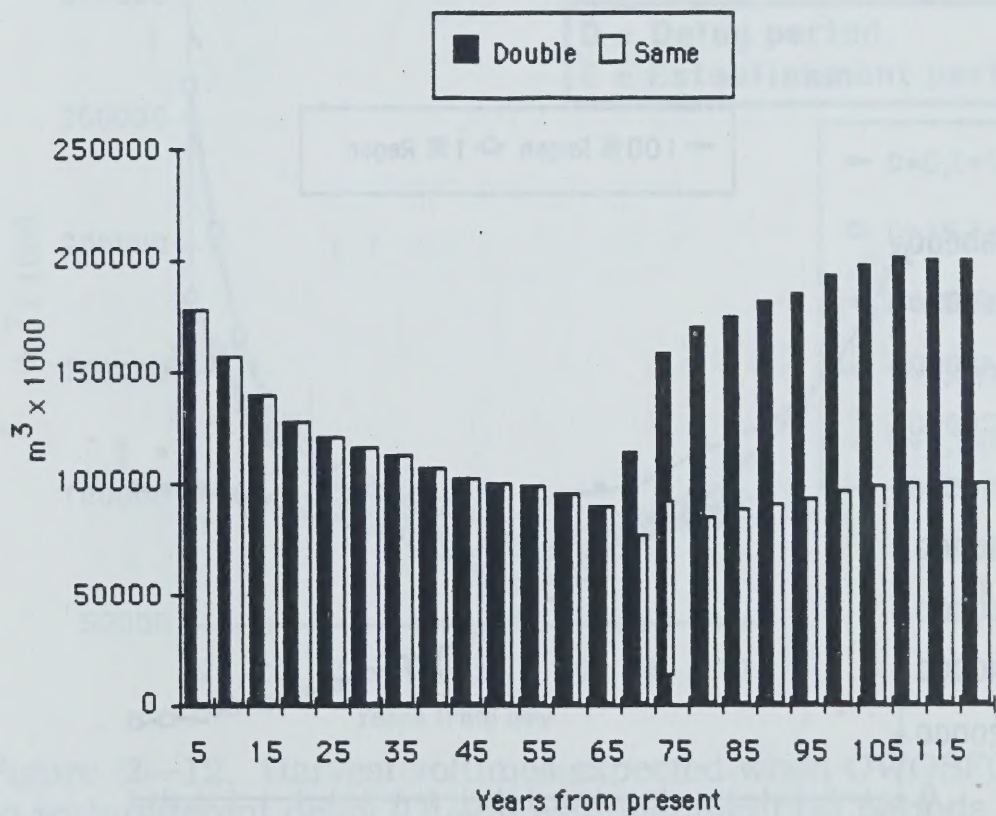


Figure 2—10. If twice the present yields per hectare are expected in the future, the OWOSFOP method of allowable cut calculation does not allow harvesting of the increased volume until 70 years in the future. This assumes that yields can be doubled and that the age-class 61—80 can be harvested.

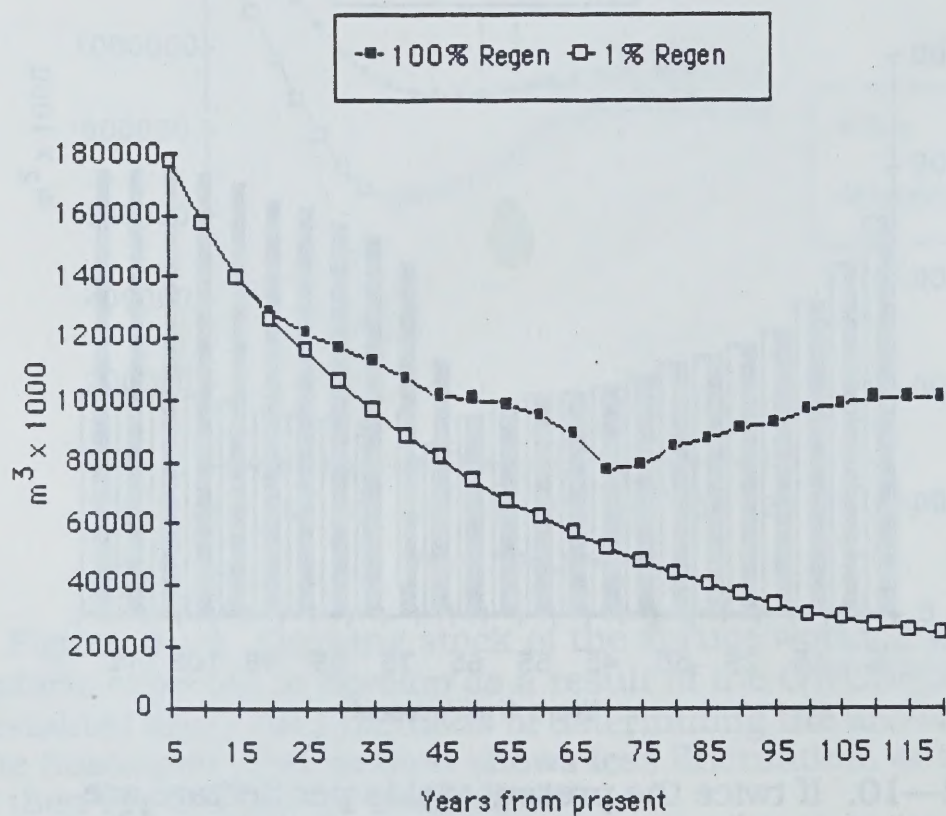


Figure 2—11. Expected volumes to be harvested based on OWOSFOP calculations for the spruce working group of Ontario. An establishment period of 10 years, and a delay period of 0 years were used for each of the two options; 100% regeneration and 1% regeneration success. Differences in the allowable cut do not occur until 15 years later.

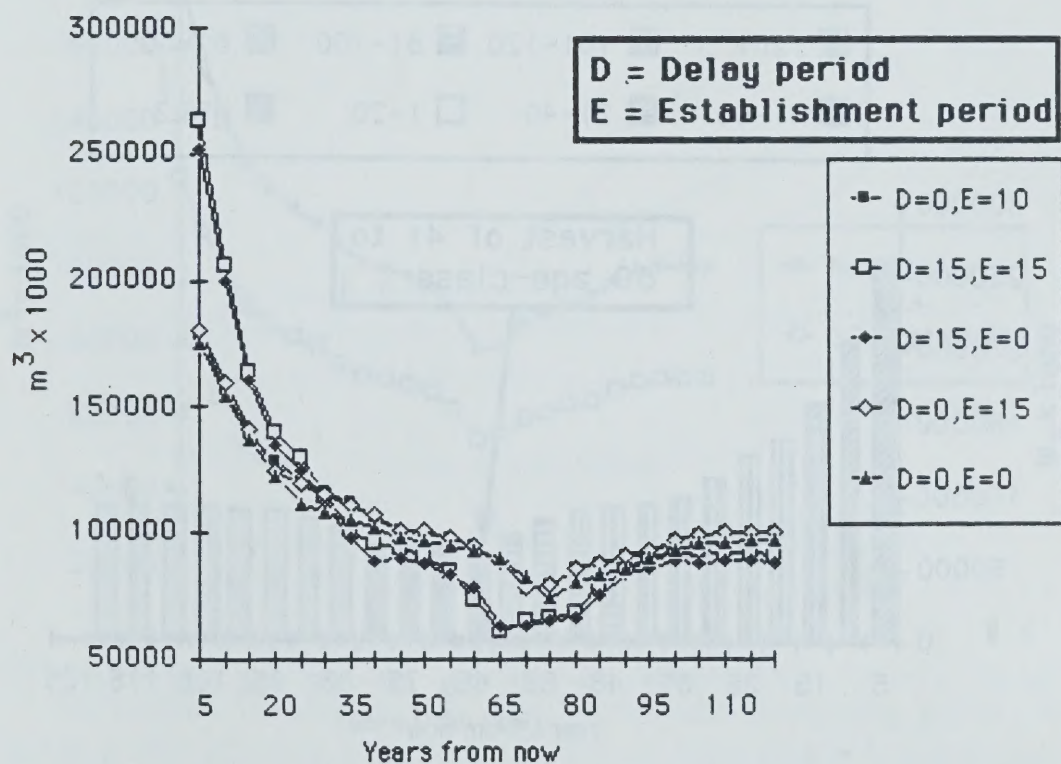


Figure 2—12. Harvest volumes expected when OWOSFOP is used with different delay (D) and establishment (E) periods for the spruce working group forest of Ontario. Increasing the delay period increases the allowable cut. A large delay period results in higher initial allowable cuts.

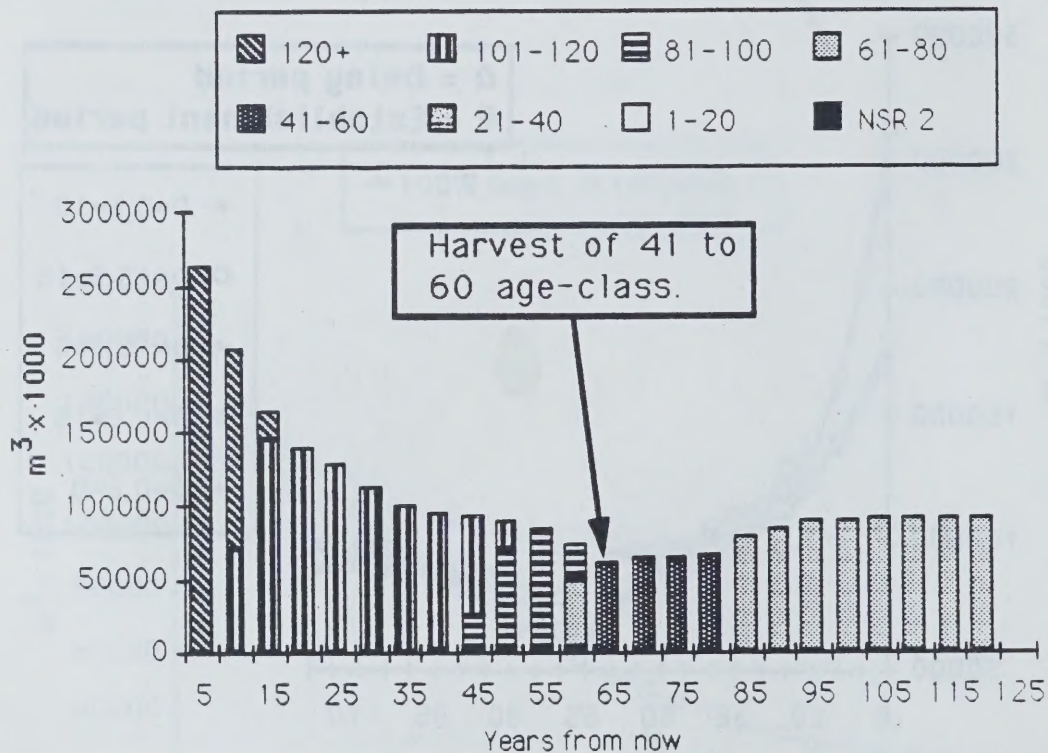


Figure 2—13. Volumes and age classes harvested for the spruce working group of Ontario, with a rotation of 90 years, delay period of 15 years, and an establishment period of 15 years. The initial harvest is increased, but harvesting of younger age-classes would occur earlier than illustrated in Figure 2 — 4 on page 25.

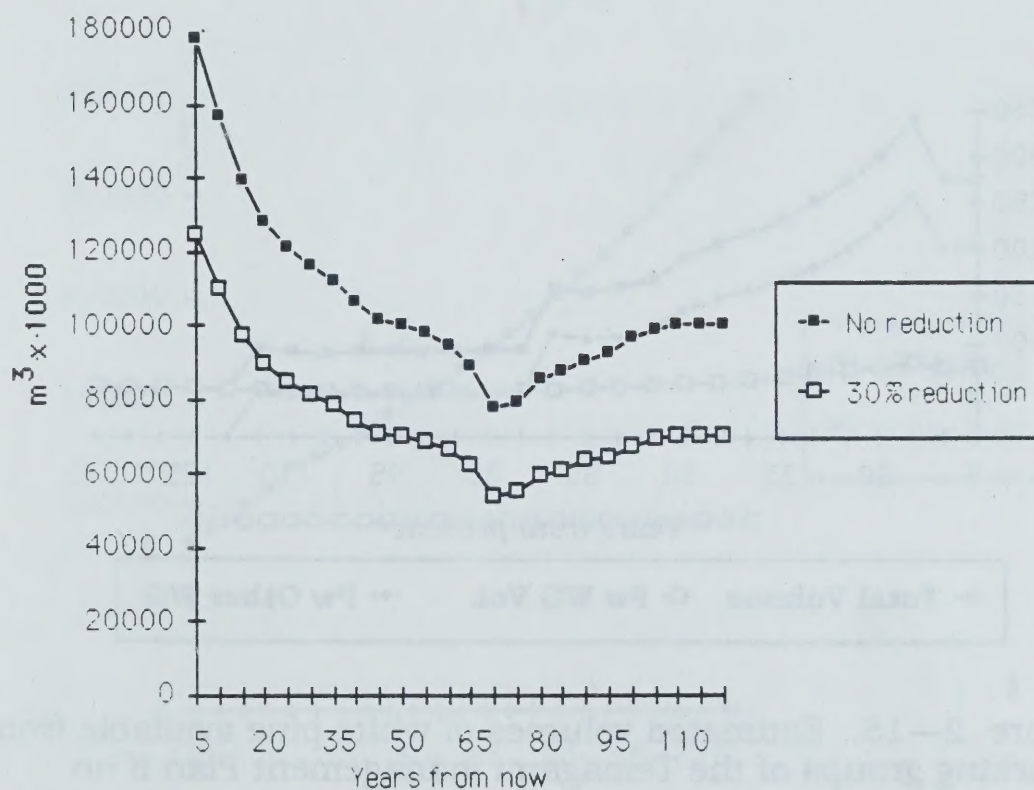


Figure 2—14. A comparison of the allowable cut for the spruce working group of Ontario determined by the OWOSFOP method using the total productive land base and the total productive land base reduced by 30% for other uses and losses.

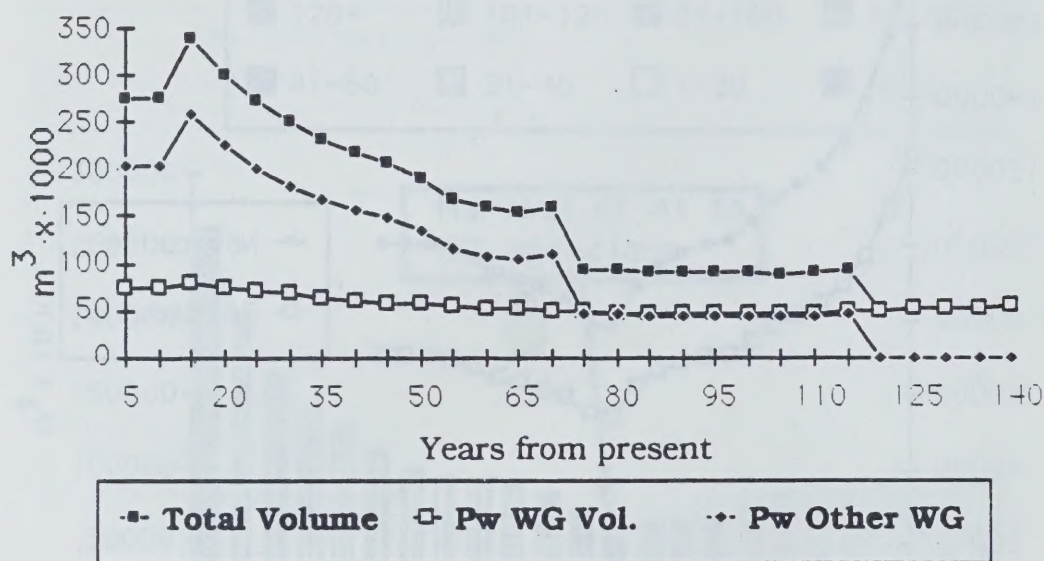


Figure 2—15. Estimated volumes of white pine available from five working groups of the Temagami management Plan if no regeneration of white pine occurs in working groups other than white pine. The estimates of the white pine volumes are based on extrapolating the operational cruise data of the first ten-year allocation. The majority of the white pine comes from the other working groups.

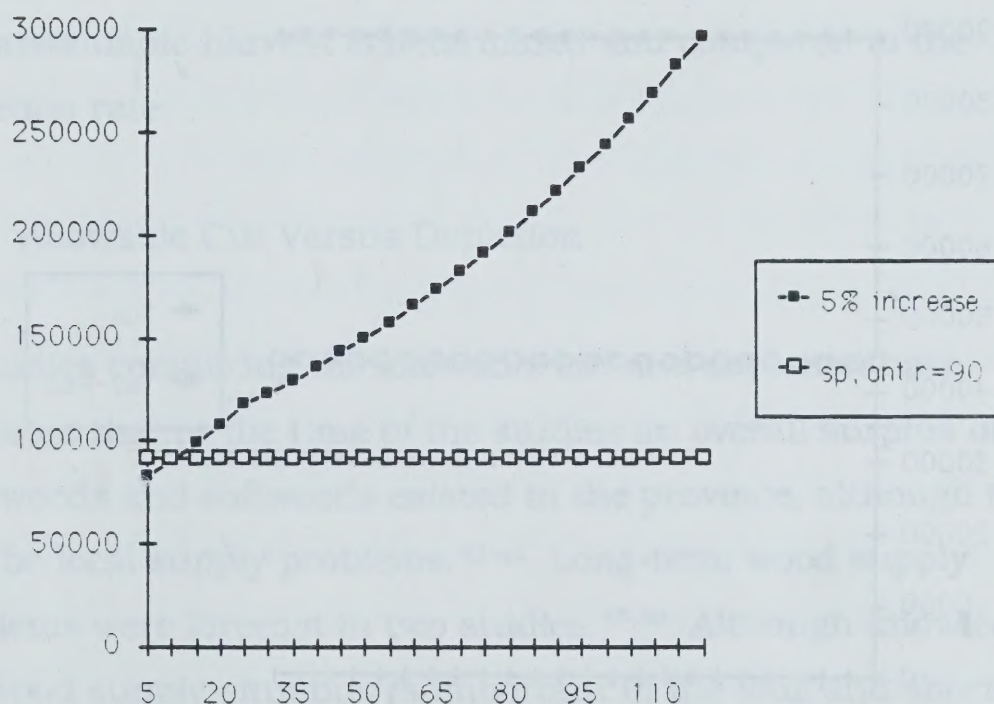


Figure 2—16. The sustainable harvest of the black spruce working group of Ontario with no increase in the land base and with an assumed 5% increase in the spruce working group land base.

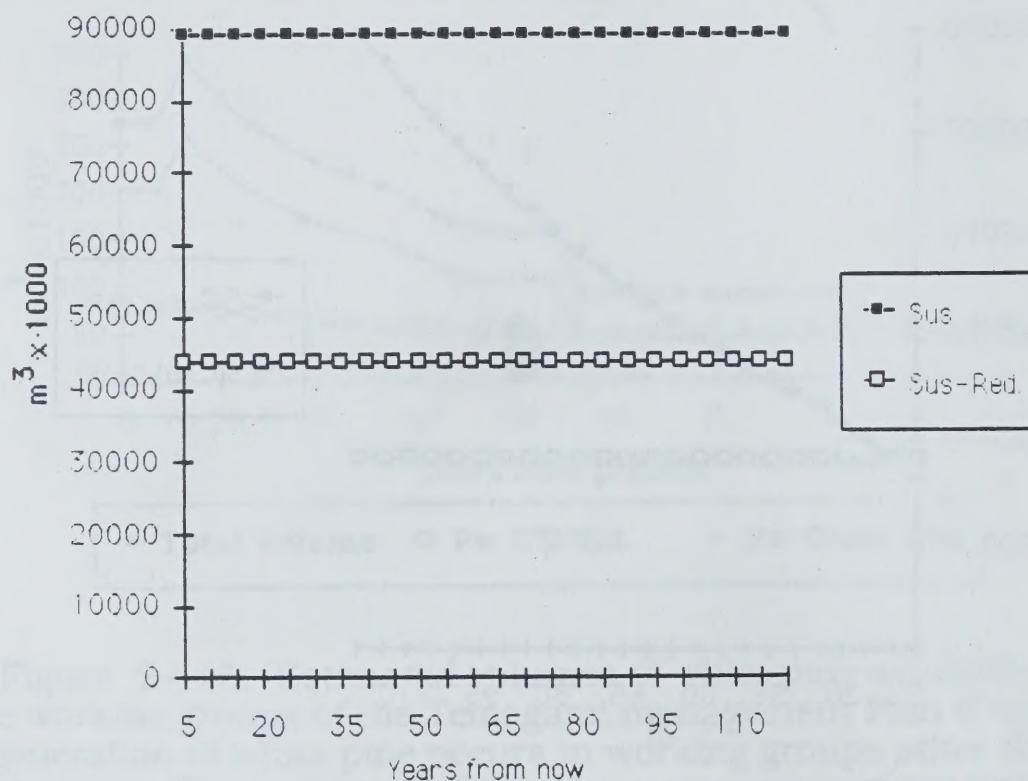


Figure 2—17. The sustainable harvest of the spruce working group of Ontario estimated before (Sus) and after (Sus-Red). The land base was reduced by 30% to account for other uses, losses to fire, insects, and disease.

3. WOOD SUPPLY

Wood supply analyses can be on a provincial or management unit basis. In this section, the wood supply on a provincial basis will be examined. There are two approaches to determine the wood supply on a provincial basis. Either a comparison is made between the allowable cut and depletion data of the province, or an estimate the sustainable harvest is determined and compared to the depletion rate.

1. Allowable Cut Versus Depletion

Studies comparing the allowable cut and depletion have indicated that at the time of the studies an overall surplus of hardwoods and softwoods existed in the province, although there may be local supply problems.⁴²⁻⁴⁴ Long-term wood supply problems were forecast in two studies.^{45,46} Although knowledge of the wood supply situation is important in the long and short-term for the economic well-being of many northern communities both

42. **Reed, F. L. C. & Associates.** 1978. Forest management in Canada. Prepared for Forest Mgt. Instit., Ottawa, Ontario. Inf. Report FMR-X-102. Vol 1. 155 pp.

43. **Anderson, F. J., and N. C. Bonsor.** 1980. The economic future of the forest products industry in northern Ontario. Prepared for the Ontario Royal Commission on the Northern Environment by Lakehead University, Thunder Bay, Ontario. 207 pp. (See pp. 164-165).

44. **Woodbridge, Reed and Associates** 1987. A study of Ontario forest products industry. Prepared for Forest Resources Group OMNR. 96 p.

45. **Reed, F. L. C. & Associates.** 1978. Forest management in Canada. Prepared for Forest Mgt. Instit., Ottawa, Ontario. Inf. Report FMR-X-102. Vol 1. 155 pp.

46. **Anderson, F. J., and N. C. Bonsor.** 1980. The economic future of the forest products industry in northern Ontario. Prepared for the Ontario Royal Commission on the Northern Environment by Lakehead University, Thunder Bay, Ontario. 207 pp. (See pp. 164-165).

types of studies are difficult to conduct with precision because of the lack of information. This has been a consistent problem with the OMNR.⁴⁷⁻⁵⁰ Since management plans have been produced for Ontario since 1947, one would expect such studies to be relatively straightforward. The determination of wood supply is similar to the production of other crops, as it requires a renewal of the crop to ensure a future harvest; but it differs because of the long time period required to grow the new crop. However, it is possible to use a variety of techniques and formulas to predict future wood supplies based on the allowable cut calculations.⁵¹

Prior to the implementation of the FMA's weighted area method of allowable cut calculation, allowable cuts were determined using both an area and a volume method. All methods are or were based on the concept of the 'normal' forest; or in some plans prior to the implementation of the FMA's, the 'fully regulated forest'. In the past, the OMNR has compiled yearly summaries of the allowable cuts and harvested area by management unit, district, region, and for the province. Before designing the new silvicultural assessment procedure, the amount and success of renewal operations were

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47. **Reed, F. L. C. & Associates.** 1978. Forest management in Canada. Prepared for Forest Mgt. Instit., Ottawa, Ontario. Inf. Report FMR-X-102. Vol 1. 155 pp.
 48. **Anderson, F. J., and N. C. Bonsor.** 1980. The economic future of the forest products industry in northern Ontario. Prepared for the Ontario Royal Commission on the Northern Environment by Lakehead University, Thunder Bay, Ontario. 207 pp. (See pp. 164-165).
 49. **Benson, C. A.** 1982. Forest management on N'Daki Menan or the Teme-Augama Anishnabai. Report prepared for the Teme-Augama Anishnabai of Bear Island, Temagami, Ontario. 137 pp.
 50. **Woodbridge, Reed and Associates** 1987. A study of Ontario forest products industry. Prepared for Forest Resources Group OMNR. 96 p.
 51. **Davis, L. S. and K. N. Johnson** 1987. Forest management. Mc-Graw-Hill Book Co., Toronto, Ont. 790 pp.

available for the province and districts. Consequently, it was theoretically possible for the OMNR to estimate present and future wood supplies. At present, the OMNR does not have summaries of the allowable cuts or amount and success of silvicultural operations for the province or the regions. Even if this information were available in an organized manner, estimates of current and future wood supplies are difficult for a number of reasons:

a). The present method of determining the allowable cut, the OWOSFOP method to calculate the MAD, produces allowable cuts, that decline with time for an overmature forest. As Ontario has a preponderance of overmature forests, the overall effect expected is a declining allowable cut in the future. Consequently, comparing the current allowable cuts to the current depletion is overly optimistic as the future allowable cuts will decline.⁵² Moreover, the fluctuations in the area and volume to be harvested as determined by using the MAD allowable cut method, makes it difficult to predict future harvest levels for the whole province. Regional models are in the developmental stage but are not operational.⁵³

b). Management unit boundaries are changed.^{54,55} By reassigning different townships to management units, with old or

52. **Woodbridge, Reed and Associates 1987.** A study of Ontario forest products industry. Prepared for Forest Resources Group OMNR. 96 p.

53. **Murphy, K. C. 1990.** Letter received in response to a number of enquiries for Forests for Tomorrow. 2 pp.

54. **Reed, F. L. C. & Associates. 1978.** Forest management in Canada. Prepared for Forest Mgt. Instit., Ottawa, Ontario. Inf. Report FMR-X-102. Vol 1. 155 pp.

55. **Benson, C.A., H. Cumming, H. Akervall, and W. Carmean 1989.** The need for a land stewardship, holistic resource management plan for N'Daki Menan. Report prepared for the Teme-Augama Anishnabai, Bear Island, Temagami, Ont. 114 pp. + appendices.

new names, the determination of the wood supply over time for a fixed area is tremendously confusing and difficult. This leads to a complication of the following problem.

c). Management plans do not indicate the historical development of their management. This should include:

i. Amount of area in a working group over time.

Maintaining a consistent area in a working group is a first step in achieving sustained yield or sustainable development. If the area of a working group decreases without being planned for, it indicates a critical problem in the management of the area. In effect, the area is being exploited rather than managed. An allowable cut is based on the concept of keeping a fixed land base in production. If the land base is reduced by the unplanned conversion to another working group, the allowable cut is not a realistic calculation, it is merely a mathematical exercise. A realistic and practical allowable cut for sustained management would be based on an area of land that can be regenerated back to the original working group. Any cut above and beyond the realistic amount should be termed for what it is, a liquidation cut.⁵⁶ The system of shifting boundaries of management unit boundaries serves to camouflage the loss of working groups in a management unit.

Even if the boundaries are not changed, a new inventory merely reclassifies areas into their current working group. The new area

56. **Benson, C. A. 1982.** Forest management on N'Daki Menan or the Teme-Augama Anishnabai. Report prepared for the Teme-Augama Anishnabai of Bear Island, Temagami, Ontario. 137 pp.

of the working group is used to determine a new allowable cut. If regeneration of a working group has been particularly unsuccessful, the effect is to have a large amount of older age-classes in the management unit, creating the impression that the cut should be increased. In the present TMP, the five-year historical record of past allowable cuts is insufficient to show the success of managing a working group. The information for a working group could be presented in a simple graphical form (see Figure 3 — 1 on page 50).

ii. Regeneration success by method and site for working groups would allow a determination of the land base that is returning to the original working group. If only certain sites can be successfully regenerated, it would indicate the type and amount of land base that could be placed under sustained yield management. Sites that cannot be regenerated successfully should be excluded from the land base used for determining the allowable cut. In addition, assessment of older regenerated areas would provide hard data for predicting future yields of a working group for a particular management unit. Reliance on data from specific sites of the province (i.e. Thunder Bay Nursery Trial)⁵⁷ or other areas of the world is not as reliable as using growth data particular to a management unit.

d). Although Ontario has been producing management plans since 1947, their production has often been delayed to the extent that they are more in the nature of historical records rather than

57. OFIA/OLMA. 1990. Statement of Evidence. Panel 8. Renewal of the Timber Resource. Environmental Assessment Hearings, Toronto, Ontario. 159 pp. + appendices. (See Appendix B).

management plans. Often, plans were never completed.^{58,59} Without a plan, allowable cuts were either not available or were estimated. The current system of requiring plans every five years may alleviate this problem.

e). In previous studies of wood supply, allowable cut and harvest that I have completed, allowable cut and harvest information was not always provided by the OMNR or companies, thus estimates or preliminary calculations of allowable cuts were made for management units.^{60,61} In the first study for the Teme-Augama Anishnabai,⁶² the Temagami District reluctantly allowed data from management units and ledgers to be hand copied over a period of two days. In contrast, the North Bay District photocopied the same type of information in 30 minutes. Although this information is now available to the public, the OMNR can still show reluctance in providing this data for detailed analysis. For example, in 1987 while collecting data for these hearings, the OMNR would only allow me to hand copy data for the Matawin-Dog River management unit. My own attempts to collect information on the

58. **Benson, C. A. 1982.** Forest management on N'Daki Menan or the Teme-Augama Anishnabai. Report prepared for the Teme-Augama Anishnabai of Bear Island, Temagami, Ontario. 137 pp.

59. **Anderson, F. J., and N. C. Bonsor. 1980.** The economic future of the forest products industry in northern Ontario. Prepared for the Ontario Royal Commission on the Northern Environment by Lakehead University, Thunder Bay, Ontario. 207 pp. (See pp. 164-165).

60. **Anderson, F. J., and N. C. Bonsor. 1980.** The economic future of the forest products industry in northern Ontario. Prepared for the Ontario Royal Commission on the Northern Environment by Lakehead University, Thunder Bay, Ontario. 207 pp. (See pp. 164-165).

61. **Benson, C.A. 1981.** Ontario wood supply and demand north or near 50° latitude. 21 pp. Report for the study **Anderson, F. J., and N. C. Bonsor. 1980.** The economic future of the forest products industry in northern Ontario. Prepared for the Ontario Royal Commission on the Northern Environment by Lakehead University, Thunder Bay, Ontario. 207 pp.

62. **Benson, C.A. 1982,** Forest management on N'Daki Menan of the Teme-Augama Anishnabai, Report prepared for the Teme-Augama Anishnabai of Bear Island Temagami, Ontario. 137 pp.

actual and allowable cut of the province have been even more frustrating and time consuming. I have been waiting since 1985 for allowable cut and harvest information requested from various levels of the OMNR and up to the level of the Premier. Although they eventually sent information in 1987, the information had numerous errors. Baskerville⁶³ experienced the same difficulty in obtaining basic management information from the OMNR, even though he was employed by them. Of the 117 management units in the province, he was only able to obtain allowable cut, depletion, and silvicultural data for 80 management units. He also noted that:

“Curiously, this is the only level at which it is not possible to easily recover general ‘performance’ data that relate to implementation of management of the resource.”

f). Allowable cut and renewal data are not summarized within a district, region, or province. The TMP states that annual reports are to be submitted for statistical and analytical purposes to both the regional office and to the director of the Timber Sales Branch to update the central management-unit record file.⁶⁴ Data to be forwarded includes depletion, renewal, and assessment of the new forest. This material is not compiled or used at either the regional or provincial level to make a preliminary estimate of the wood supply situation for a management unit, region or the province.⁶⁵

g). The land base used for determining the allowable cuts is

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63. **Baskerville, G.L. 1986.** An audit of management of the Crown forests of Ontario. A report prepared for the Ontario Ministry of Natural Resources. Ont. Min. Nat. Resour., Toronto. Ont. 97 pp.
64. **OMNR 1986.** Timber management planning manual for Crown lands in Ontario. (revised to 15 Feb 1988). Ont. Min. Nat. Resour., Toronto. Ont. 217 pp.
65. **Murphy, K. C. 1990.** Letter received in response to a number of enquiries for Forests for Tomorrow. 2 pp.

based on land that may be assigned to reserves that may not be harvested. Without knowing the actual land base to be managed for timber production, estimates of wood supply are less reliable.

h). Expected volumes for existing stands based on Forest Resources Inventory data or operational cruising may not have a relationship to the scaled volumes from the area.⁶⁶ Future volumes of plantations are not known.

2. Sustainable Harvest Compared to Depletion

Comparisons of the sustainable harvest to the depletion have indicated a surplus of wood being produced over the amount depleted by harvesting fire and insects,⁶⁷ or in a more recent study, a depletion level higher than the sustainable level for conifers, but the reverse for hardwoods.⁶⁸ This latter study is particularly important as it is based on historical data for the years 1977-1981. The sustainable yield is changed when the productive land base is reduced or enlarged. The change that occurs in the productive land base is the difference between the losses (harvesting, fire, and pests) and accrual (regeneration) are indicated in Figure 3 — 2 on page 51.

66. **Rosehart, R. 1987.** An assessment of Ontario's forest resources inventory system and recommendations for its improvement. Prepared for the Ont. Min. Nat. Resour. by The Ontario Forest Resources Inventory Committee. OMNR, Toronto, Ont. 45 pp.

67. **Bickerstaff, A., and W. L. Wallace. 1981.** Growth of forests in Canada. Part 2: A quantitative description of the land base and the mean annual increment. Environ. Canada, Can. For. Serv., Petawawa National Forestry Institute, Chalk River, Ontario. Info. Rep. PI-X-1. 136 pp. (See P. 112).

68. **Honer, T., and A. Bickerstaff. 1985.** Canada's forest area and wood volume balance 1977-1981. Can. For. Serv., Pacific Forestry Centre, Victoria, B. C., 84 pp. (See pp. 81-83).

A comparison of the average annual accruals and depletions from Honer *et al.* for the years 1977-1981 and from OMNR Statistics for the years 1982-1988. Both comparisons indicate that depletions exceed accruals. Such a situation will lead to a depletion of the productive land base and a lower sustainable yield. The average annual natural regeneration of 313 265 ha consists of 14 671 ha documented in the OMNR Statistics and 298 594 ha that are assumed to occur on the fire and pest depleted areas (see Table 3— 1 on page 49). If this assumption is wrong, the depletion level could be much higher.

Information on the depletions and accruals by working group for the province would be informative, as changes in the sustainable levels of the working groups would be apparent. Unfortunately, such information for the province is not available, but the SOARS report⁶⁹ and Frisque *et al.* (1978)⁷⁰ indicate that balsam fir and hardwoods are forming a larger component of the forest.

3. Conclusions on The Wood Supply

On the basis of the studies that have been completed for the province, it is apparent that there will be a problem to maintain the current levels of harvest in the future. It is not a lack of artificial regeneration that leads to this conclusion, but the lack of

69. **OMNR 1989.** Survey of artificial regeneration in northern Ontario. Exhibit 553. Environmental Assessment Hearings, Thunder Bay, Ontario. 22 pp.

70. **Frisque, G., G. F. Weetman and E. Clemmer 1978.** Reproduction and trial yields 10 years after cutting 36 pulpwood stands in Eastern Canada. For. Eng. Res. Inst. of Canada, Pointe Claire, Quebec. Tech. Rep. No. TR-23. 63 pp.

information on the regeneration that does occur naturally or artificially on depleted areas. The majority of the depleted area is regenerated naturally, but scant information is available regarding the state of the regeneration. Sustainable levels of conifers, other than balsam fir, are probably being reduced as the depletion exceeds the accruals. The time and amount of the reduction will vary for each management unit. Where harvesting has occurred for some time concomitant with a lack of regeneration, the reduction in the sustainable level of harvest is apparent now⁷¹ (See Part II).

The insidious characteristic of changes in wood supply is that they usually occur slowly over a length of time, rather than as a drastic drop or rise. With no records of the changes that occur with respect to composition and growth characteristics of the forest over a period of time, declines in wood supply may not be identified or quantified. However, the general principle of use of a resource without replacing it with a future forest of comparable quality will inevitably lead to a decline in future wood supplies.

71. Benson, C.A., H. Cumming, H. Akervall, and W. Carmean 1989. The need for a land stewardship, holistic resource management plan for N'Daki Menan. Report prepared for the Teme-augama Anishnabai, Bear Island, Temagami, Ont. 114 pp. + appendices.

Table 3—1. Estimations in hectares of the average annual accruals and depletions to the productive land base for Ontario. Based on data from Honer and Bickerstaff (1985) for the years 1977-1981 and OMNR Statistical reports for the years 1982-1988.

	<u>Honer <i>et al.</i></u>	<u>OMNR Statistics</u>
Productive Land Base	36 820 000	21 304 747*
Depletions		
Annual harvest		191 000
187 316		
Fire	101 000	167 094
Pests	<u>263 000</u>	<u>131 500</u> **
Subtotal	555 000	485 910
Accruals		
Artificial regeneration	54 000	71 963
Natural Regeneration	<u>414 000</u>	<u>313 265</u> ***
Subtotal	468 000	385 227
Difference	-87 000	-100 683

*Based on calculation of Natural Regeneration chapter.

**Assumed to be one-half of Honer *et al.*'s value.

***It was assumed that all the fire and pest depletion area regenerated naturally.

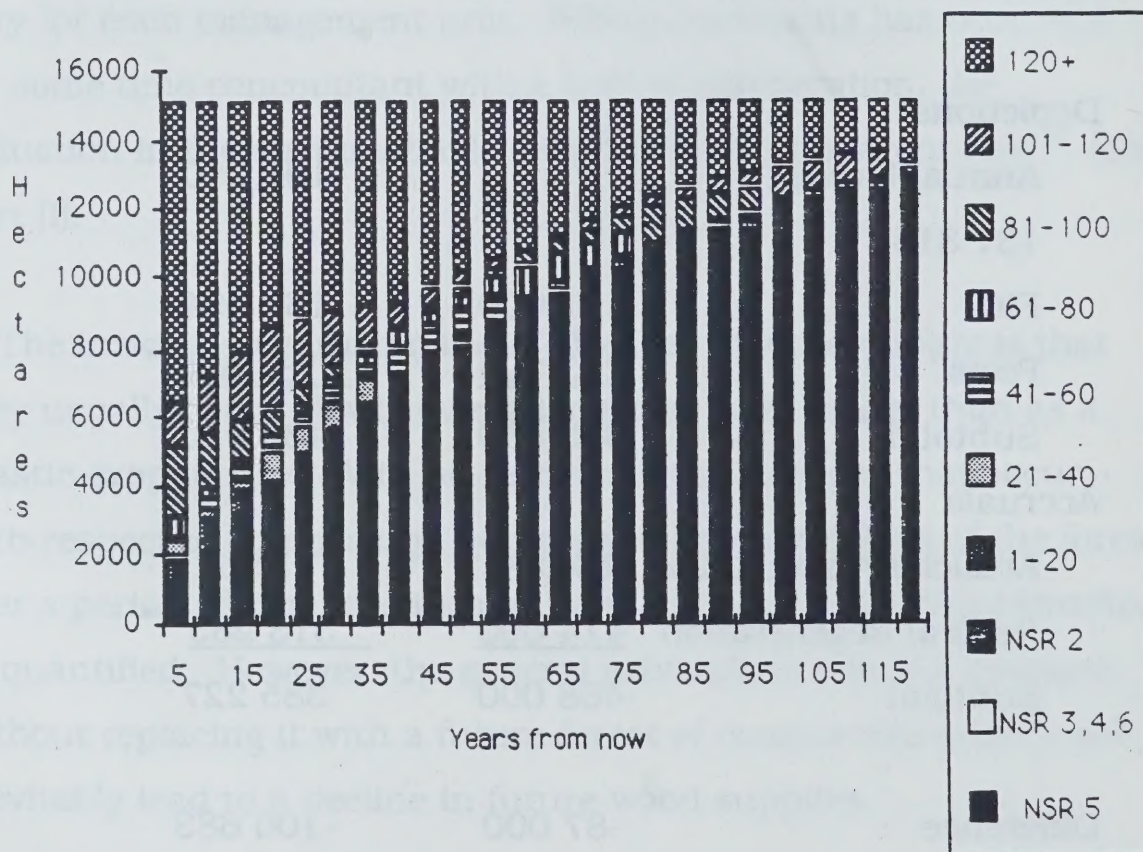


Figure 3—1. Depiction of the success of management of a working group over time with a 5% success in regenerating the working group. The steady increase of the NSR 5 category makes it obvious that the working group is being depleted.

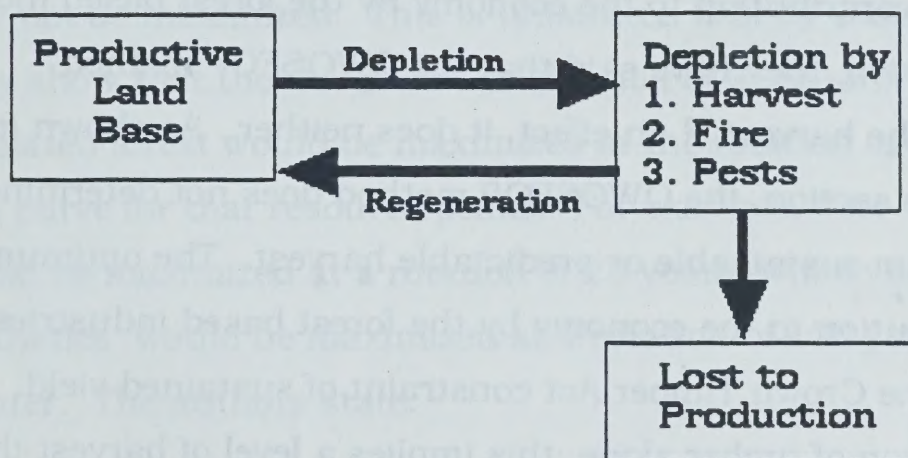


Figure 3—2. Maintaining a sustained yield depends upon balancing the depletions and accruals to the productive land base.

4. INTEGRATED RESOURCE MANAGEMENT OR HOLISTIC MANAGEMENT

1. Optimizing and Maximizing.

The OMNR's aim strives for an optimum and/or continuous predictable contribution to the economy by the forest based industry. In addition, they have said that the OWOSFOP method maximizes the harvest.⁷² In effect, it does neither. As shown in the previous section, the OWOSFOP method does not determine the maximum sustainable or predictable harvest. The optimum or best contribution to the economy by the forest based industries is subject to the Crown Timber Act constraint of sustained yield. For the production of timber alone, this implies a level of harvest that produces a fully regulated forest. Other constraints on the management of the forest for timber are that the forest operations be consistent with sound environmental practices and to provide for other users of the forest. These other constraints have not been quantified by the OMNR to allow their effect on the optimum harvest level to be determined. The OMNR has dodged the critical issue of managing all the resources of the forest by relying on classical methods to determine production of trees only from the forest.

In order to achieve multiple use management (integrated resource management, or holistic management), the other elements

72. OMNR 1989. Environmental Assessment Hearings, Panel XV, Appendix C. Thunder Bay, Ontario.

of the forest must be considered in the planning stage. An example of a step towards considering all elements of the forest are the management plans of the U.S. Forest service.^{73,74} Their method identifies the features of the forest that they hope to provide and the target levels they hope to achieve. With the constraints quantified, the optimum levels of production for all resources of the forest can be determined. Fundamental in the management of multiple resources is the realization that the production of all resources may not be maximized. This is illustrated best by Calish *et. al*.⁷⁵ They show that the maximum production of a resource of the regulated forest would be maximized at the rotation age where the MAI curve for that resource peaks. For example, deer production would be maximized at a rotation of 25 years, while visual aesthetics would be maximized at a rotation of 100 years or greater. The authors state:

"Faced with such functions, the manager cannot simultaneously maximize all outputs-a compromise is necessary."

Similar functions could be derived for Ontario. Theoretically, moose production in Ontario could be maximum in the fully regulated forest at a rotation of about 35 years, while visual aesthetics could theoretically reach a maximum at a rotation

73. **USDA Forest Service 1985.** Draft environmental impact statement land and resource management plan. Superior National Forest. U.S. Forest Service, Duluth, Minn. 7 separately paginated chapters + appendices.

74. **USDA Forest Service n.d.** Proposed land and resource management plan. Superior National Forest. USDA Forest Service, Duluth, Minn. Separately paginated chapters + appendices.

75. **Calish, S. R., D. Fight, and D. E. Teeguarden 1978.** How do nontimber values affect Douglas-fir rotations? *J. For.* 76:217-221.

greater than 120 years (see Figure 4 — 1 on page 60 and Figure 4 — 2 on page 61). A rotation age of 70 years for maximum timber production (see Figure 2—1 on page 22), is between these values for moose and visual aesthetics, thus can not maximize either moose production or visual aesthetics. It should be noted that the rotation of 70 years for maximum volume production of spruce is based on Forest Resources Inventory data, and would be different for individual management units depending on growing conditions and utilization standards. In my experience, the maximum production would occur at a higher age.

The age-class distribution of a forest is one factor that determines the production of various resources. For example, a fully regulated forest of 20 000 hectares and a rotation of 200 years is theoretically capable of producing 9 harvestable moose and an aesthetic index rating of 4000. The same forest area with a rotation of 50 years, would produce more harvestable moose, 70, but have a lower aesthetic index, 2060 (see Table 4 — 1 on page 63).

Because of the limitations of the OMNR inventory for all resources, the Ontario management planning system identifies and plans for the production of resources other than timber based on what is identified in the five-year allocation.⁷⁶ Although such an approach is an advance over completely ignoring the other resources, it is not clear what levels of production are being aimed for. The relationship of the targets of the District Land Use Plans to the levels that will be produced by the management employed is

76. OMNR 1986. Timber management planning manual for Crown lands in Ontario. (revised to 15 Feb 1988). Ont. Min. Nat. Resour., Toronto, Ont. 217 pp.

ambiguous at best. Presumably the levels of resources left after timber allocations are "to provide for other users of the forest".

2. Expectations of Users

The expectations of the owners and users of the land, the public, can not be optimized until their expected demands are related to the production capabilities of the other resources. Both the levels of production of the other resources and the expectations of the owners of the resource must be determined. Production functions for the various other resources are not quantified for the area of undertaking. Concerns of the public have been identified for Canada⁷⁷ and could be for the Province of Ontario. Interestingly enough, this document was not introduced by the OMNR or the industry. Two of the most interesting points of this survey were that:

a). Of all respondents, 94% felt that the public should have a greater say in forest land use decisions.

b). Only 12% felt that the most important use of forest lands in Canada was logging, while 2% favoured wilderness preservation and 27% favoured wildlife protection.

At present, the OMNR system of identifying the concerns of the public is confined to the open house process. This process does allow individuals with specific concerns to identify those concerns for the five-year allocated area; however, it does not allow the

77. **Forestry Canada 1989.** Public opinion survey of Canadians regarding forest management.

public to gain an appreciation of what the overall objectives are for managing the various resources of the forests of a management unit. There are three reasons for this:

a). The relationship of the management proposed is not specifically related to target levels that are expected to be achieved for all resources.

b). The method the OMNR uses to arrive at the compromise decisions, that must be made in the management of multiple resources, is not clear. Methods do exist for reaching rational compromise solutions to complex multiple use problems.^{78,79}

c). The necessity of the OMNR to recognize that

“the forest is a single biophysical system that responds as a system to the manipulation of any of its parts; social perceptions of utility are volatile and unstable; the scarce factor of production is capital”.⁸⁰

Harvesting of trees affects the wildlife, scenic beauty, nutrient cycle, energy flow, hydrology, and other elements of the system.⁸¹

An observation on the nature of multiple use forest management is as follows:

78. **Tak, K.I. 1988.** Integrated resource management planning through the use of mathematical and judgement-based models. MSc Thesis. Lakehead University, Thunder Bay, Ont. 124 pp.

79. **Bonnicksen, T.M. 1987.** EZ-IMPACT (The judgement-based systems modeling and decision analysis program). Biosocial Decision Systems, Texas. 219 pp.

80. **Behan, R.W. 1990.** Multiresource forest management a paradigmatic challenge to professional forestry. *J. For.* 88(4), 12-18.

81. **Duerr, W.A., D.E. Teeguarden, N.B. Christiansen, and S. Guttenberg 1979.** Forest resources management. W.B. Saunders Co., Toronto. 612 pp.

"People often ask me, 'Why aren't our forests sustainable? Aren't we replanting after we cut?' My response is that a forest is not a plantation. A forest is a mosaic, including ancient trees, venerable giants providing shelter for wildlife. A forest is clear, pure water, rivers alive with trout and salmon. A forest is wilderness, silence. A forest is tall, straight trees for house beams and logs. A forest is a wellspring of value for rural people. A forest is the deep, rich, soil soaking and storing water and nutrients. The fact that we can grow young trees where all this once stood does not mean we have perpetuated the forest. The task of protecting and restoring the forest is more complex. It demands all the skill, imagination, and dedication of foresters. This is the art of forestry."⁸²

3. Considering the Future

The difficulty of planning for a public forest to meet the demands of the users from a limited resource base is complicated further by the fact that the demands may vary over time. At any given point in time, the plan for the development of the forest must consider the present demands, yet provide the opportunity to meet future demands that may emphasize different elements of the forest. To attain sustainable development requires management that will meet "the need's of today's population without compromising the ability of future generations to meet theirs."⁸³ It is impractical to expect that present management can foresee all the demands, and their levels, that will be placed on the **forests for tomorrow**. It is possible to plan to provide for all the resources

82. Carey, H.H. 1989. Forest trust: two-year report. 1987-1988. The Forest Trust. Santa Fe, NM. 14 p. Original not seen, quoted from Behan, R.W. 1990.

83. Benson, C.A., H. Cumming, H. Akervall, and W. Carmean 1989. The need for a land stewardship, holistic resource management plan for N'Daki Menan. Report prepared for the Teme-augama Anishnabai, Bear Island, Temagami, Ont. 114 pp. + appendices.

of the forest by recognizing the forest as a system,⁸⁴ and plan for the maintenance of all the elements of the forest. In practical terms this means planning to include the natural forest in all age-classes and in a variety of sizes on all site types. The OWOSFOP method of determining the allowable cut, if resolutely applied to the forest would lead to the elimination of the older age classes (see Figure 4 — 3 page 62). The OMNR contends that in practice older stands will be left, but there is no assurance that the maintenance of all the elements of the forest will occur other than by chance.

Planning to retain a forest of all age-classes conflicts directly with the practice of harvesting and plantation management. The solution to such a dilemma is to establish a management system that recognizes the demands of timber production while at the same time specifically provides for the older growth forest. At present, the OMNR system leaves reserves, that may or may not be cut, around some lakes and streams. These areas are relatively small and will not include the feature of large areas of older growth or ensure that all site types are covered. Rather than determining the present use in such an ad hoc fashion, the forest could be managed to provide for maintaining all resources of the forest, for today and tomorrow.

4. Planning Elements Necessary

Managing the forest to optimize the management of the forest for

84. Duerr, W.A., D.E. Teeguarden, N.B. Christiansen, and S. Guttenberg 1979. Forest resources management. W.B. Saunders Co., Toronto. 612 pp.

all resources requires:

- a). Determination of the production levels possible for each resource of a management unit.
- b). Determination of the levels of production desired by the users of the forest.
- c). Determination of the management procedures that will maximize user satisfaction or minimize their dissatisfaction.
- d). Determination of the allocation of management procedures to optimize the production of all resources for the management procedures selected.

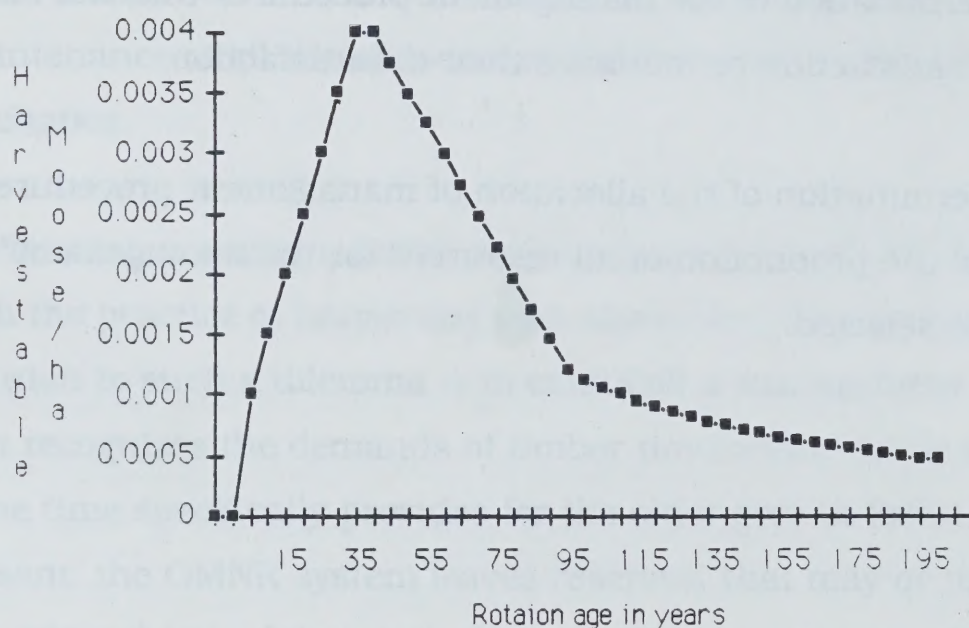


Figure 4—1. Theoretical production levels of harvestable moose for managing a fully regulated forest at different rotations.

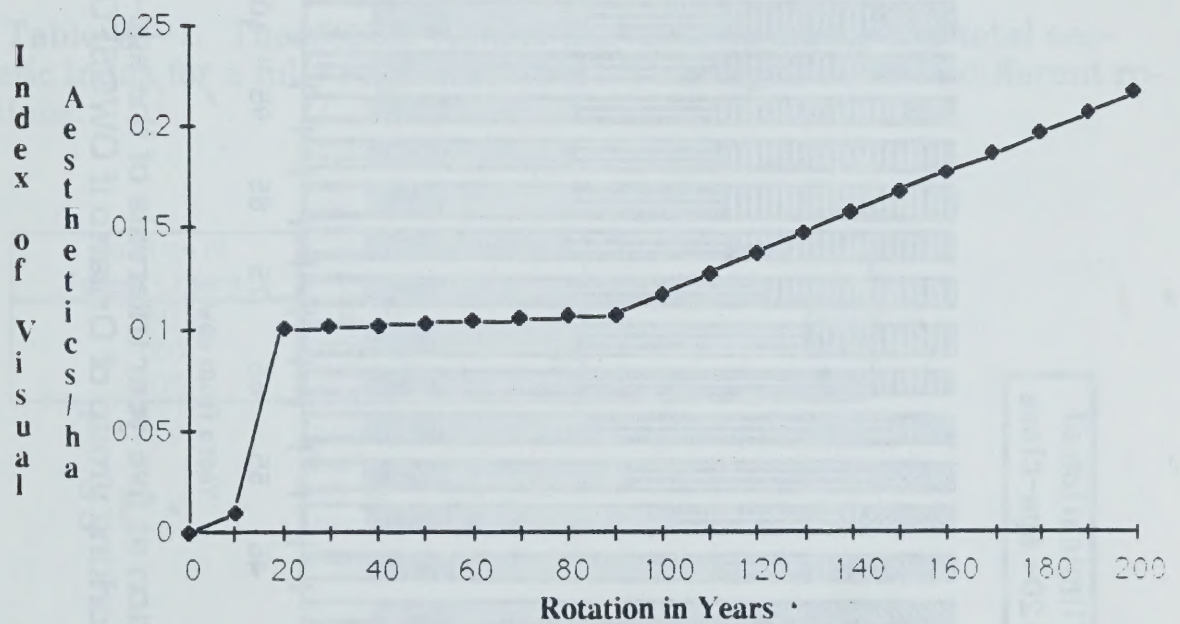


Figure 4—2. Theoretical aesthetic values for a fully regulated forest at different rotation ages.

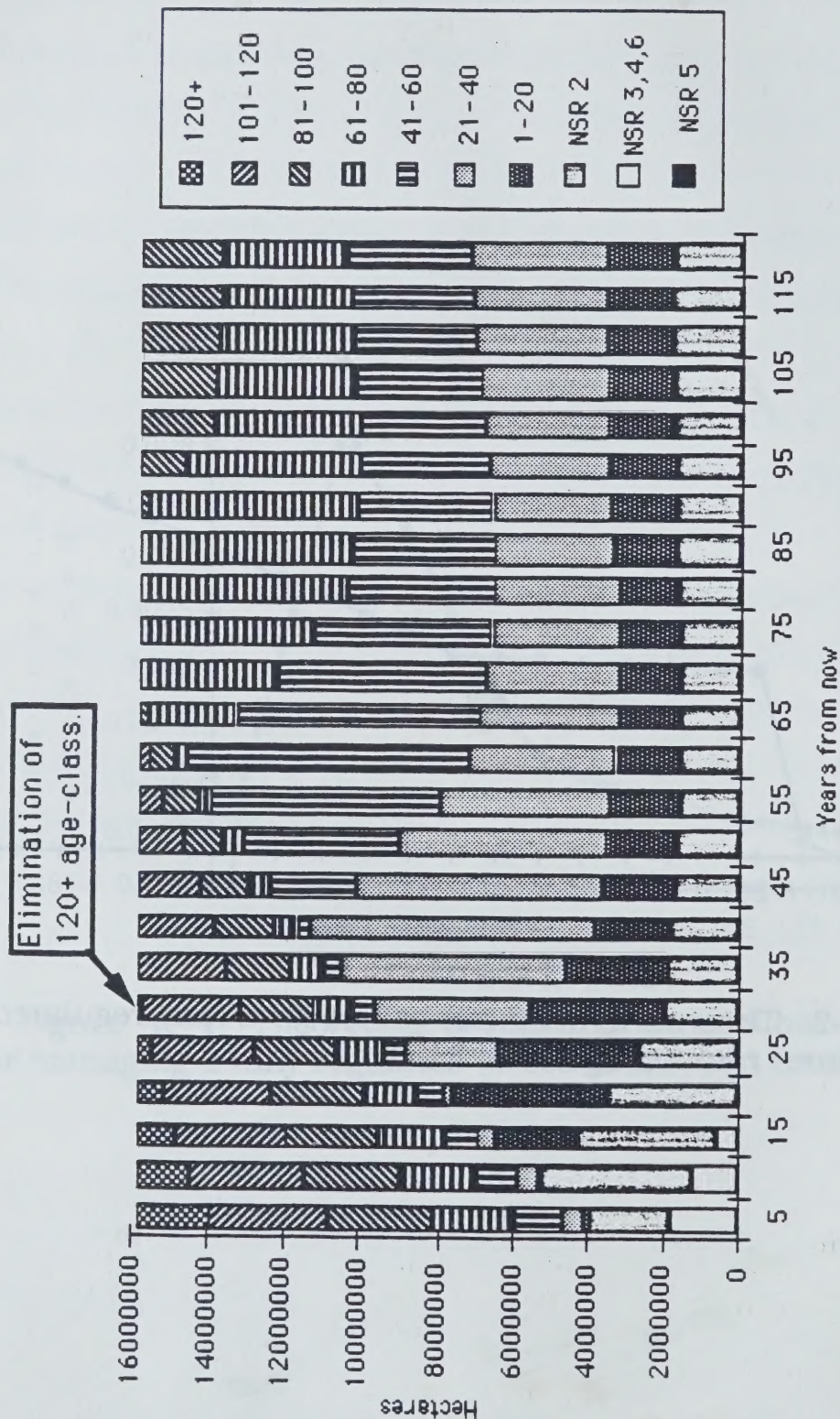


Figure 4—3. Area distribution at five-year intervals of the age-classes of the spruce working group working group of Ontario if OWOSFOP is fully implemented for a rotation.

Table 4—1. Theoretical yield of harvestable moose and total aesthetic index for a fully regulated forest if managed at three different rotations.

Rotation of Forest (Years)	Harvestable moose	Recreation index
50	70	2060
100	22	2400
200	9	4000

5. PLANNED NATURAL REGENERATION AND PRODUCTIVITY.

Planned natural regeneration of the area of the undertaking is recommended over artificial regeneration for three main reasons:

1. The natural productive capability of the forest.
2. Economic Concerns
3. Ecological Concerns

1. The Natural Productive Capability of the Forest.

The average MAI at rotation age of the forests of Ontario is 1.7 gross merchantable m^3/ha .⁸⁵ In the area of the undertaking, 30 120 747 ha of forest are available for production (Production forest plus protection forest reserve).⁸⁶ Other estimates of productive forest land in Ontario are 47 794 000 ha,⁸⁷ 29 321 000 ha,⁸⁸ 38 285 000 ha,⁸⁹ and 34 870 000 ha.⁹⁰ For the area classed as Crown forest, the LTSY (Long Term Sustained Yield) of all species is

85. **Bickerstaff, A., W. L. Wallace and F. Evert 1981.** Growth of forests in Canada Part 2: A quantitative description of the land base and the mean annual increment. Can. Dep. Environ., Can For. Serv., Petewawa Nat. For. Inst., Info. Rep. PI—X—1. 136 pp.
86. **OMNR 1986.** The forest resources of Ontario. Ont. Min. Nat. Resour., Toronto, Ontario. 110 pp. Exhibit 56.
87. **Bickerstaff, A., W. L. Wallace and F. Evert 1981.** Growth of forests in Canada Part 2: A quantitative description of the land base and the mean annual increment. Can. Dep. Environ., Can For. Serv., Petewawa Nat. For. Inst., Info. Rep. PI—X—1. 136 pp.
88. **Bonner, G.M. 1982,** Canada's forest inventory 1981. Forestry Statistics & Systems Branch. Canadian Forestry Service, Chalk River, Ontario. 79 pp.
89. **Forestry Canada 1988.** Canada's forest inventory. Forestry Canada, Ottawa, Ontario. 60 pp.
90. **Reed, F.L.C. & Associates Ltd. 1978.** Forest management in Canada Volume 1. Forest Management Institute, Canadian Forestry Service, Ottawa, Ontario. Info. Rep. FMR-X-102. 155 pp.

51 205 270 m³ (1.7 m³/ha times 30 120 747 ha = 205 270 m³). If the 8 816 000 ha of land in Ontario unsuitable for commercial economic use⁹¹ is assumed to occur in the area of the undertaking, the LTSY on the remaining 21 304 747 ha (30 120 747 ha minus 8 816 000 ha = 21 304 747 ha) is 36 218 070 m³ (1.7 m³/ha times 21 304 747 ha = 36 218 070 m³). When a reduction of 12% of the area (2 556 570) is applied to account for the loss to insects, disease, fire, roads, and reserves,⁹² the land base effectively available for timber production is reduced to 18 748 177 ha (21 304 747 ha minus 2 556 570 ha = 18 748 177 ha). The LTSY of this area is 31 871 902 m³ (1.7 m³/ha times 18 748 177 ha = 31 871 902 m³). This final figure is sufficient to meet the provincial timber production target⁹³ of 25.8 million m³ and probably the other documented timber production target⁹⁴ of 33.9 million m³. The higher target of 33.9 million m³ could likely be met considering the variety of estimates for productive forest land. It means that the natural forest, if replaced with a similar forest, will be sufficient to meet the production policy target.

Sustained yield management for the forest of Ontario was recommended by the Royal Commission on the Northern Environment:

91. **Bickerstaff, A., W. L. Wallace and F. Evert** 1981. Growth of forests in Canada Part 2: A quantitative description of the land base and the mean annual increment. Can. Dep. Environ., Can. For. Serv., Petewawa Nat. For. Inst., Info. Rep. PI-X-1. 136 pp.
92. **van Frassen, A. M.** 1982. The effect of the spruce budworm problem on policy and planning. in The Spruce Budworm Problem In Ontario--Real Or Imaginary?, COJFRC Symposium Proceedings O-P-11. Can. For. Serv., Sault Ste. Marie, Ontario. pp 57-60.
93. **OMNR** 1972. Forest production policy in Ontario. Ont. Min. Nat. Resour., Division of Forests, Toronto. 67 pp. Exhibit 136.
94. **Osborn, J. E.** 1983. Budworm and the Ontario forest resources inventory -- calibrations for a crystal ball. in The spruce budworm problem in Ontario -- real or imaginary? COJFRC symposium proceedings, pp. 61-66. Can. for. Serv., Sault Ste. Marie, Ont. COJFRC symposium proceedings O-P-11, 116 pp.

"5.9 Recommendation:

That sustained yield be imposed by law as an essential aspect of all forest management in Ontario."⁹⁵

The major reason the OMNR espouses for using the OWOSFOP method of allowable cut determination is to:

"cut through the overmature timber earlier and faster, and potentially produce higher yield from the forest,"⁹⁶

The major flaw in this approach is that a relatively small proportion of the productive forest land is classed as overmature while the majority is immature.⁹⁷

Intensive silviculture activities strive to increase the production of a species from an area. The increase in volume may be obtained by increasing the stocking of the desired species, at the expense of other species that may normally occupy the site,⁹⁸ and/or using genetically superior stock. In Ontario, genetic improvement may not be expected for several decades.⁹⁹

"In the boreal forest region, however, we do not yet have forest tree material which is certifiably 'improved' on the basis of test data. It will be several decades before

95. **Fahlgren, J.E.J. 1985.** Final report and recommendations, the Royal Commission on the Northern Environment. Ministry of the Attorney General, Toronto, Ontario. Separately paginated chapters. (see p5-16).
96. **Tworzyanski, T. 1987.** Annual cut versus forest depletion: Ontario's approach to wood supply analysis. Canadian Forest Industries, Sep pp. 565-569.
97. **Bonner, G.M. 1982.** Canada's forest inventory 1981. Forestry Statistics & Systems Branch, Canadian Forestry Service, Chalk River, Ontario. 79 pp.
98. **Smith, D.M. 1986.** The practice of silviculture. John Wiley & Sons Inc., Toronto, Ontario. 527 pp. (p. 196).
99. **Farmer, R. E., P Knowles, and W. H. Parker. 1982.** Genetic resources of the North American Boreal forest. pp. 40—51. *in* Resources and Dynamics of the Boreal Zone. Proceedings of a Conference, Thunder Bay, Ontario.

stock that is certified 'improved' for a 70-year rotation (the life span of a tree) is available."

Release operations provide more growing space for the desired species by reducing the number of other plants and trees.¹⁰⁰ Total volume production of all trees will likely be reduced.¹⁰¹ This may be advantageous in a situation where the crop rotations are short and the final crop will meet the requirements of the mill. In the area of the undertaking, rotations are long and the final species required for future mill requirements may not be known with a degree of certainty. Future mills may utilize different or all species.¹⁰² Thus, concentrating volume production of an area on a specific species may, in effect, reduce the total volume available to mills of the future that will be adapted to the changed markets and technology.

Spacing of a plantation may produce the same volume as a non-spaced plantations or natural stand, but will have a MAI curve that will peak sooner.¹⁰³ This MAI curve may peak somewhat higher than for the non-spaced stand and would produce a somewhat higher LTSY than the non-spaced forest. For example, if the net merchantable volume at rotation of black spruce was 170 m³, the MAI is 1.7 m³/ha/yr. If spacing improved volume production to produce 170 m³ at 90 years the

100. **Smith, D.M. 1986.** The practice of silviculture. John Wiley & Sons Inc., Toronto, Ontario. 527 pp. (p. 132).
101. **OFIA/OLMA 1990.** Panel 7 interrogatories for Forest for Tomorrow, Question 13. Roe (1951) study. Environmental Assessment Hearings, Toronto, Ontario.
102. **Benson, C. A. 1988.** A need for extensive forest management. For. Chron. 64: 421—430.
103. **Willcocks, A. J. F. W. Bell, J. Williams, and P. N. Duinker 1990.** A crop-planning process for northern Ontario forests. Ont. Min. Nat. Resour., Northwestern Ontario forest Technology Development Unit, Thunder Bay, Ont. NWOFTDU Tech. Rep. #30. 159 pp. (p. 26).

MAI would be $1.89 \text{ m}^3/\text{ha}/\text{yr}$, an 11% increase in volume. The increase, if economically feasible, would still be made under the assumption that future volumes of the particular species spaced, will be in demand in the future. Actual volumes harvested per hectare vary considerably by management unit, but average $113 \text{ m}^3/\text{ha}$ for the province (see Table 5 — 1 on page 73). Industry estimates of future yields per hectare have been up to 71 cords/acre ($422 \text{ m}^3/\text{ha}$) and are unduly optimistic.¹⁰⁴

Production of levels of different working groups indicate that poplar is the highest yielding species in the short run (see Figure 5 — 2 on page 71 and Figure 5 — 3 on page 72). Estimates of the yield tables are higher than actual harvest levels per hectare.

The most recent actual harvest levels¹⁰⁵ for the province are less than the LTSY, 20 million m^3 , and have been less in the past (see Figure 5 — 1 on page 70). Baskerville¹⁰⁶ found that on 80 management units the actual cut area was only 49% of the allowable rate for softwoods and 40% for the hardwoods. For volume on the same 80 management units, he found that 50% of the softwood forecasted volume was harvested, while 19% of the softwood volume was harvested. Reviews of Forest Management Agreements show that for most of the FMA's, the depletion is less than the maximum allowable depletion.¹⁰⁷⁻¹¹⁰ Out of the 120

104. **Transcripts Environmental Assessment Hearings 1990.** p. 36931.

105. **OMNR 1989.** Statistics. Ont. Min. Nat. Resour. Toronto, Ont. 117 pp.

106. **Baskerville, G. L. 1986.** An audit of management of the Crown forest of Ontario. OMNR. Toronto, Ont. 97 pp. Exhibit 16.

107. **OMNR 1985.** Forest management agreements. Five-year review 1980-1985. Ont. Min. Nat.

individual forest units in the FMA's examined in these reviews, only seven exceeded the maximum allowable depletion and only three of these were for large areas of forests units.¹¹¹ While it is perhaps fortunate for future timber supply that less than the inflated allowable cuts as calculated using OWOSFOP are being harvested, it does raise the question of why is it necessary to increase the production by using expensive silvicultural techniques in an attempt to increase the productivity of the forest.

Resour., Toronto, Ontario. 110 pp. Exhibit 68.

108. **OMNR 1987.** Forest management agreements. Second five-year review 1981-1986. Ont. Min. Nat. Resour., Toronto, Ontario. 93 pp. Exhibit 31.
109. **OMNR 1988.** Forest management agreements. Third five-year review 1982-1987. Ont. Min. Nat. Resour., Toronto, Ontario. 128 pp. Exhibit 69.
110. **OMNR 1989.** Forest management agreements. Fourth five-year review 1983-1988. Ont. Min. Nat. Resour., Toronto, Ontario. 72 pp.
111. **OFIA/OLMA 1990.** Panel 3 Interrogatories (wood Supply) responses to Forests For Tomorrow, Question #6. Environmental Assessment Hearings, Toronto, Ontario. 1 p.

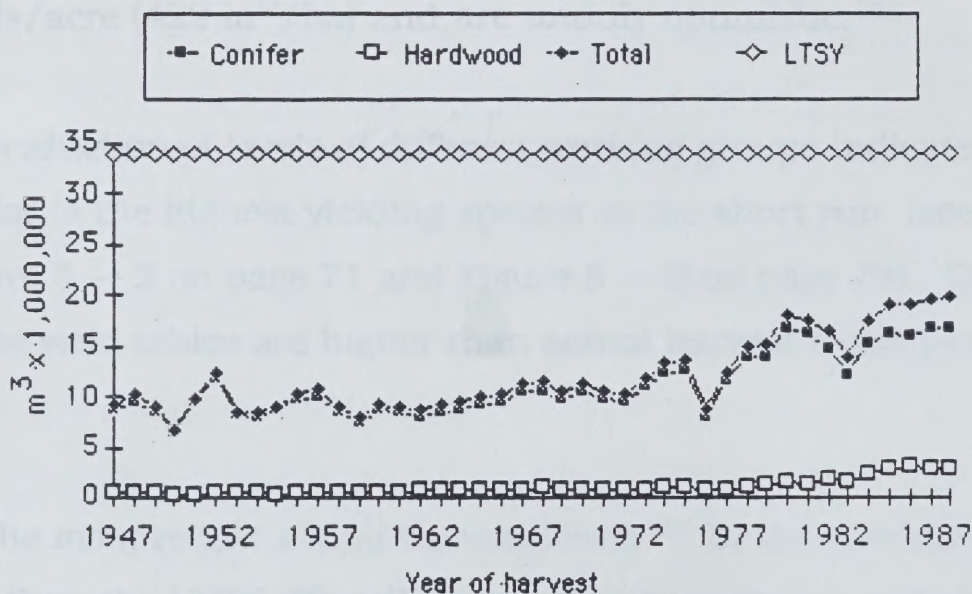


Figure 5—1. Harvest cut of Ontario from 1947 to 1988 compared to LTSY (Long Term Sustainable Yield). Conifer includes spruce, jack pine, balsam fir, white pine, red pine, cedar, tamarack, and other conifer. Hardwood includes poplar and white birch, while total includes all the aforementioned species. The LTSY assumes that 100% successful regeneration of harvested areas to the same working group would occur.

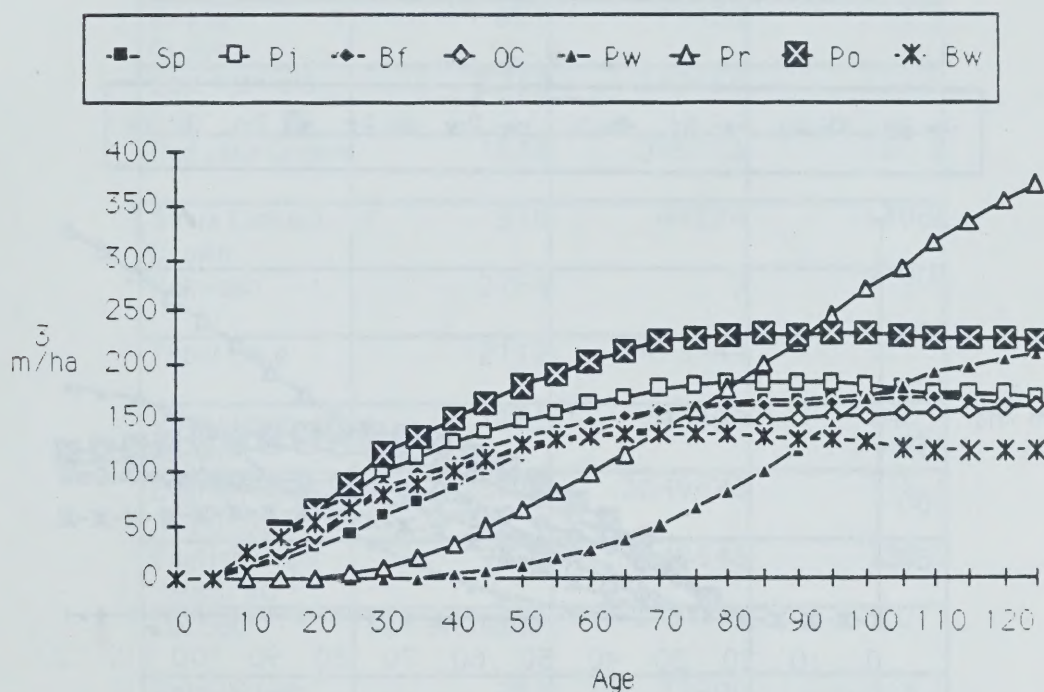


Figure 5—2. Gross merchantable volumes for species of Ontario. Data are from The Forest Resources of Ontario¹¹² and Northeastern Region yield tables.¹¹³

112. OMNR 1986. The forest resources of Ontario. Ont. Min. Nat. Resour., Toronto, Ont. 110 pp. Exhibit 56.

113. OMNR n.d. Yield tables for the major working groups and site regions of the Northeastern Region, Sudbury, Ontario. Separate non-paginated pages for each working group.

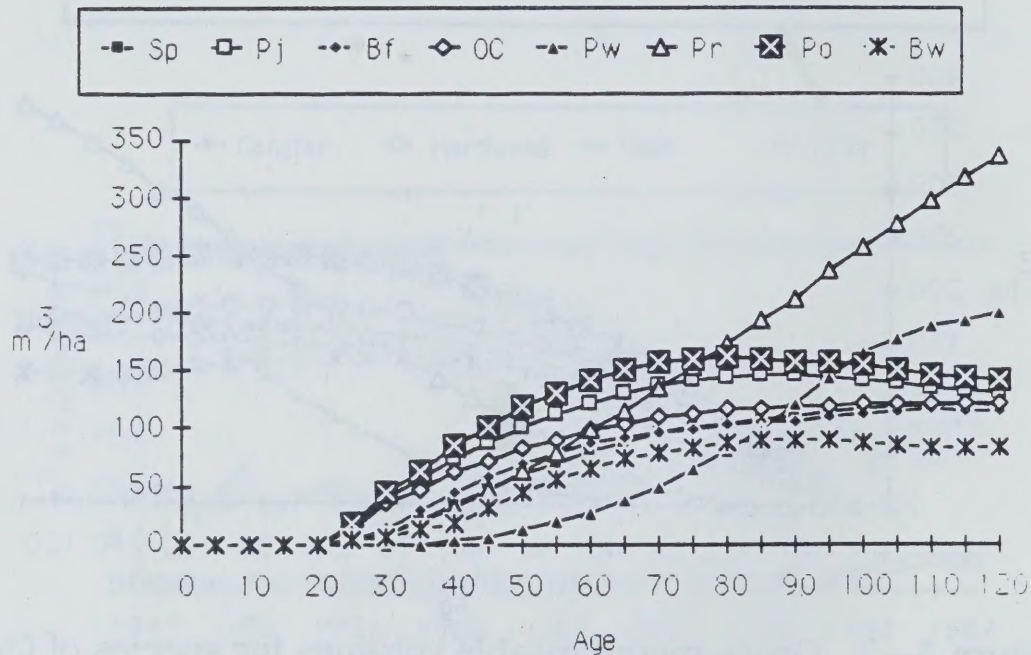


Figure 5—3. Net merchantable volumes of species of Ontario. Data are from The Forest Resources of Ontario and Northeastern Region yield tables. The Cull Survey Tables and Northeastern Region yield table were used to obtain net merchantable volumes.¹¹⁴

114. OMNR 1978. Cull survey tables (metric). Ont. Min. Nat. Resour., Toronto, Ont. 51 pp.

Table 5—1. Average volume per hectare for management units across Ontario. Area and volume harvest figures are for up to the year 1986/87 for most management units. The actual harvest figures may be for one to five years of harvest.

Management Unit	Actual Harvest (hectares)	Actual Harvest (m ³)	Average Volume/ha (m ³ /ha)
Dryden Crown	657	74436	113.3
East Patricia	3739	390668	104.5
Red Lake Crown	1839	295833	160.9
Sioux Lookout Crown	316	44204	139.9
Pakwash	2754	0	0.0
Trout Lake	12112	1473444	121.7
Rainy Lake Crown	1282	243800	190.2
English River 1980/85	26436	3049426	115.4
English River 1985/90	9522	1240848	130.3
Lac Seul	NOT available		
Rainy River	251	79900	318.3
Manitou 1982/87	12500	1280600	102.4
Manitou 1987/92	NOT available		
Seine River 1982/87	7592	1030500	135.7
Seine River 1987/92	NOT available		
Aulneau	1641	142921	87.1
Lake of the Woods	973	45077	46.3
Minaki	1847	170642	92.4

(continued on next page)

Table 5—1 continued

Nakina	2610	360249	138.1
Longlac	6085	875937	144.0
Lake Nipigon 1981/86	14815	1407817	95.0
Lake Nipigon 1986/91	3835	355985	92.8
Kiashke	NOT available		
Black River 1981/86	3472	575220	165.7
Black River 1986/91	3574	380846	106.6
Big Pic	3430	418377	122.0
Spruce River 1981/86	35474	3288400	92.7
Spruce River 1986/91	10042	831050	82.8
Black Sturgeon	14482	6828491	471.5
Dog River Matawin	34305	2927465	85.3
Brightsands	11843	1358867	114.7
White River	13214	1659929	125.6
Magpie	20466	1564540	76.4
Lower Spanish	volumes NOT available for 1980 to 1990		
Moose river	Volumes NOT available.		
Hearst	Area NOT available.		
Nagagami 1982/87	14808	1349113	91.1

(continued on next page)

Table 5—1 continued

Nagagami 1987/92	Harvest area NOT available.		
Gardiner 1982/87	3496	497557	142.3
Cochrane	3403	438284	128.8
Driftwood	Volume and area harvested NOT available.		
Iroquois Falls 1980/85	18594	1834290	98.6
Iroquois Falls 1985/90	14771	1170355	79.2
Cochrane Crown 1988/93	Area and volume NOT Available		
Timmins forest 1983/88	4911	466976	95.1
Timmins forest 1988/93	Area and volume information NOT available.		
Romeo Malette 1982/87	11193	1530431	136.7
Romeo Malette 1987/92	Area and volume information NOT available.		
Gorden Cosens 1980/85	58715	5288985	90.1
Gorden Cosens 1985/90	29644	2512577	84.8
Walter Plonski 1988/93	Area and volume information NOT available		
Upper Spanish 1980/85	10539	2070000	196.4
Upper Spanish 1985/90	7134	1096000	153.6
J.E.Martel 1987/92			
Pineland 1982/87	13432	837166	62.3
Pineland 1987/92	Area information NOT available.		

(continued on next page)

Table 5—1 continued

Superior 1987/92	Area and volume information NOT available		
Lanark 1982/87	1640	131040	79.9
Tweed 1985/90	4780	161907	33.9
TOTAL	458167	51780153	
AVERAGE	113.0m ³ /ha		

6. PLANNED NATURAL REGENERATION AND ECONOMIC CONCERNS.

1. Factors Affecting the Economics of Forest Management

A more detailed examination of the economics of forest management is found in the witness statement for Forests for Tomorrow dealing specifically with economics. Conventional economic analysis of the worth of doing intensive silvicultural projects indicate that intensive silviculture operations in Ontario cannot be carried out at a profit. The Canada Land Inventory indicates that the majority of the land in the area of the undertaking, as classified, is in the lower categories of "moderately severe limitations to the growth of commercial forests" (Class 4) to "lands that have severe limitations which preclude the growth of commercial forests (Class 7)".^{115,116} Anderson¹¹⁷ found negative NPV (Net Present Value) for silvicultural operations using stumpage rates of \$10.00 to \$50.00 per cunit, while Benson¹¹⁸ found that with a stumpage rate of \$10.00 per m³, only the extensive management alternative shows a profit at a low rate of interest rate, 4%. The more intensive silvicultural operations were at a loss. Extensive forestry is defined as:

- 115. **Environment Canada n.d.** Land capability for forestry. Ontario. Environ. Canada. Lands Directorate, Ottawa, Ontario. 1 map, 1:1,000,000.
- 116. **Simpson-Lewis, W., J. E. Moore, N. J. Pocock, M. C. Taylor, H. Swan. 1979.** Canada's special resource lands: A national perspective of selected land uses. Environ. Canada. Lands Directorate, Ottawa, Ontario. 232 pp. (p. 159).
- 117. **Anderson, F. J. 1979.** Ontario reforestation policy: benefits and costs. Can Public Policy. 5: 336—347.
- 118. **Benson, C. A. 1988.** A need for extensive forest management. For. Chron. 64: 421—430.

"The practice of forestry on a basis of low operating and investment costs per acre".¹¹⁹

It involves the use of modified cuts and other management procedures to encourage natural regeneration. Extensive is sometimes used to indicate forestry operations that are extensive in the area that the operations cover rather than the cost of the operation as defined by the SAF definition. Intensive management is:

"The practice of forestry so as to obtain a high level of volume and quality of outturn per unit of area through the application of the best techniques of silviculture and management".¹²⁰

The low stumpage, low yields per hectare, and long rotations contribute to the low economic return expected from the average forest site in Ontario. Stumpage reflects the major direct return to the province for the production of trees for industrial use. Growing the tree crop at a loss represents a form of social cost to the province, rather than a profitable investment. Investing \$1000.00 at 4% interest would be worth \$50,504.94 in 100 years. If the yield in 100 years was 200 m³, the stumpage would need to be \$252.52 per m³ as compared to a present stumpage of \$7.00 /m³ for conifer and \$1.71/m³ for poplar and white birch.¹²¹

119. **SAF 1983.** Terminology of forest science technology practice and products. Society of American Foresters, Washington, D.C. 370 pp.
120. **SAF 1983.** Terminology of forest science technology practice and products. Society of American Foresters, Washington, D.C. 370 pp.
121. **Canadian Pulp and Paper Association 1989.** A survey of stumpage and other forest management charges relating to Crown lands in Canada. Forest Management Working Group. CPPA. Montreal, Québec. 10 pp. not paginated.

Recognition of the poor return on investment was noted by the Ontario Economic Council¹²² when they stated:

"All of the procedures which promote the establishment of the second crop, except planting which is economically feasible in only a few locations, are related to the cutting of the timber, and must, therefore, be practiced by industry. If government is to insist on the proper regeneration of an area, it must have funds to pay for the work undertaken in this regard and the necessary funds must come, as far as possible, from the operation of the mature timber taken from the area."

Suggestions have been made to consider the cost of regenerating the forest as part of the cost of doing business rather than consider them as capital investments. Perhaps the best comment on this type of analysis was by Anderson:¹²³

"Private sector managers who would not consider an investment in plant and equipment that failed to yield "normal" after-tax returns are apparently willing to advocate such investments in timber capital provided they are funded by the public sector."

One of the main advantages that we have in competing in the world forestry market is the low price of exploiting a natural forest rather than growing more intensive and expensive plantation forests, and concomitant higher stumpage fees, similar to the Scandinavian countries and the United States.¹²⁴ Remaining competitive in the future will require production of the cheapest

122. **Ontario Economic Council.** 1970. A forest policy for Ontario. Queen's Publisher, Toronto. Ontario. 38 pp. Exhibit 73.

123. **Anderson, F. J.** 1985. Natural resources in Canada. Economic theory and policy. Methuen, Toronto. 301 pp.

124. **Pittis, D. E. B.** 1987. Canada places export tax on softwood lumber. *J. of For.* 85(5): 19—23.

wood possible.^{125,126} Natural regeneration costs have been found to have either no increase in harvesting costs¹²⁷ or a slight increase in harvesting costs.¹²⁸

About 70 319 ha (33%) of 213 847 ha of cutover are treated intensively in Ontario.¹²⁹ Increasing the amount of area treated intensively will only increase the amount of the subsidy. Industry has expressed their concern over the continuity of government funding. It is unlikely that the government will be able to provide the amount of funding necessary to intensively manage all the forest land, and there are signs that government funding is decreasing.^{130,131} Intensive management requires a continuity of effort. Without a continuity of funding, it is unlikely that intensive management will be successful.

Fire is still a major threat to our forests (see Figure 6 — 1 on page 89), in spite of increased measures of control.¹³² No downward trend is evident in the area burnt, number of fires, and area per fire (see Figure 6 — 2 on page 90,

125. **Macdonald Report 1985.** Report of the Royal Commission on the economic union and development prospects for Canada. Vol. II. Min. Supply and Services, Ottawa. 827 pp.

126. **Canadian Council of Forest Ministers 1987.** A national forest sector strategy for Canada. *For. Chron.* 60: 310—333.

127. **Begin, J. 1986.** Modification of harvesting techniques to foster natural regeneration. CPPA, Canadian Forest Industries. WSI 2961 (bi) (F—4) ODC 231.49. Nov pp. 31—40.

128. **Johnson, J. D., J. H. and Smyth 1987.** Harvesting and renewal costs of stripcutting relative to those of clearcutting on shallow-soil sites in north central Ontario. *Can. For. Serv., Sault Ste. Marie, Ont. Info. Rep. O—X—380*. 15 pp.

129. **OMNR 1989.** Statistics. Ont. Min. Nat. Resour. Toronto, Ont. 117 pp.

130. **Waldram, J. M. 1989.** Past, present and future forest management agreements in Ontario. Sep. pp. 54—60.

131. **OFIA/OLMA 1989.** Statement of Evidence Panel 8. Renewal of the timber resource. Environmental Assessment Hearings, Toronto, Ontario. (See Section 9 pp. 134-157.)

132. **Van Wagner, C.E. 1988.** The historical pattern of annual burned area in Canada. *Forestry Chronicle*, June, pp. 182—185. (Exhibit 1001.)

Figure 6 — 3 on page 91, and Figure 6 — 4 on page 92). With the risk of fire destroying a plantation being so high, the attractiveness of investing in intensive management is decreased further.

The longer rotations of the species grown in the area of the undertaking makes it difficult to know with any degree of certainty what the future demand will be for each species. The utilization of species has varied considerably over time and it is unlikely that the same species will have the same use in the future.^{133,134}

Intensive management, if it is to be applied, should be on the more productive sites close to the mills. Harvest areas for the next twenty years in Ontario are predicted to be on areas that are increasingly difficult to access, farther from the mills and of low site class.¹³⁵

2. Natural Regeneration In Use

Regeneration of harvested areas by natural regeneration is obtained on the majority of the cutover areas of Ontario, although only a portion of this natural regeneration is by planned harvest (see Figure 6 — 5 on page 93). Conifer areas harvested without using procedures for encouraging natural regeneration of desirable species have formed stands with an increase in the

133. Olson, J. E. 1986. The depletion myth. Harvard Press, Cambridge, Massachusetts.

134. Behan, R.W. 1990. The RPA/NFMA: Solution to a nonexistent problem. *J. of For.* 88:5, pp. 20—24.

135. Osborn, J. E. 1985. Quality of the next 20 years's wood supply in Canada. *Pulp and Paper Canada*. 87(4): 37—40.

balsam fir component.^{136,137} In spite of the lack of harvesting methods to encourage natural regeneration, some areas have managed to regenerate to young desired stands.^{138,139} Prior to 1981, the OMNR classed cutover land as area regenerating naturally, area requiring regeneration treatment, and area not available for regeneration treatment.¹⁴⁰ These areas that were not available for regeneration treatment prior to 1981, and the areas not classed as other than cutover since 1981 will probably regenerate to some species. However, they may regenerate to a different working group than desired and they may require a longer rotation period than used in the management plans. Considering the importance that has been attached by the OMNR and forest industry to practicing intensive silviculture, it appears incongruous that so much cutover occurs without planning for regeneration.

Planned natural regeneration is used in Québec¹⁴¹ and will likely become the trend in provinces that have made regeneration costs the responsibility of the harvesting companies. At least one country in the world, Yugoslavia, uses natural regeneration as the

136. **Kennedy, H. 1947.** Report of the Royal commission on forestry. King's Printer, Toronto, Ontario. 196 pp. + maps. (Exhibits 62 and 108.)

137. **Frisque, G., G. F. Weetman and E. Clemmer 1978.** Reproduction and trial yields 10 years after cutting 36 pulpwood stands in Eastern Canada. For. Eng. Res. Inst. of Canada, Pointe Claire, Québec. Tech. Rep. No. TR-23. 63 pp.

138. **OMNR 1987.** Forest management agreements. Second five-year review 1981-1986. Ont. Min. Nat. Resour., Toronto, Ontario. 93 pp. (Exhibit 68.)

139. **OMNR 1989.** Forest management agreements. Fourth five-year review 1983-1988. Ont. Min. Nat. Resour., Toronto, Ontario. 72 pp.

140. **Benson, C. A. 1981.** Ontario: Two trees planted for each one cut? For. Chron. 57:3 pp. 104-106.

141. **Québec 1989.** Modalités d'intervention en milieu forestier. Ministère de l'Énergie et des Ressources, Québec. 81 pp.

primary means of regeneration.¹⁴²

Costs for natural regeneration may be higher initially, but in the Kiashke management unit modified harvesting was completed at a competitive cost.¹⁴³ In addition, the 2.4 to 4 ha size blocks were concluded to meet the needs of other users of the forest more satisfactorily than if clear cutting was used.¹⁴⁴ A complete economic analysis of the value of intensive and extensive management is difficult to do without the necessary information on the production possible for various users under the two silvicultural alternatives. However, the relative impact of extensive management would be to produce smaller overall negative effects on the other resources of the forest as well as provide more acceptable management to the people of Ontario.¹⁴⁵

3. Economic Analyses Of Regeneration By The OMNR

a). Value Added

The OMNR has used economic analysis in three cases.¹⁴⁶⁻¹⁴⁸

142. **Yugoslavia 1986.** The forestry of Yugoslavia. XVIII IUFRO World Congress, Ljubljana. 258 pp. (p. 179).
143. **Fahlgren, J.E.J. 1985.** Final report and recommendations, the Royal Commission on the Northern Environment. Ministry of the Attorney General, Toronto, Ontario. Separately paginated chapters. (see p5-26).
144. **Fahlgren, J.E.J. 1985.** Final report and recommendations, the Royal Commission on the Northern Environment. Ministry of the Attorney General, Toronto, Ontario. Separately paginated chapters. (see p5-25).
145. **Benson, C. A. 1990.** The potential for integrated resource management with intensive or extensive forest management: reconciling vision with reality-the extensive management argument, For. Chron. (In press).
146. **OMNR 1972.** Forest production policy in Ontario. Ont. Min. Nat. Resour., Division of Forests, Toronto. 67 pp. (Exhibit 136).
147. **Hynard, P. P. 1984.** A decision-making model for forest managers using economic considerations. Ont. Min. Nat. Resour., Toronto. 27 pp + appendices.

These analyses use value added for the value of the forest to be produced. They incorrectly use the value added of the end product to justify expenditures for intensive silviculture projects, which is only part of the production process. To appreciate value added, the examples of (see Table 6 — 1 on page 94, and Table 6 — 2 on page 95) illustrate value added at different stages of producing pulpwood for intensive and extensive management respectively.

The most significant point is that the value added does not increase with intensive silviculture. In both tables, the value added is \$900.00 and equals the value of income. With the intensive silviculture options more value is added at the regeneration level (\$25.00 compared to \$1.00), but the value added by the standing tree, stumpage, component is less (\$25.00 compared to \$49.00).

Value added is used for determining the gross national product.¹⁴⁹ The components that make up the production sequence represent the amount that people are willing to pay at different stages of production. How much people are willing to pay for a product depends upon their economic analysis of that particular product. In the case of the regeneration product, it was illustrated above that the intensive management investment option is not economically feasible. Using intensive silviculture to increase the regeneration component valued added

148. Willcocks, A. J. F. W. Bell, J. Williams, and P. N. Duinker 1990. A crop-planning process for northern Ontario forests. Ont. Min. Nat. Resour., Northwestern Ontario forest Technology Development Unit, Thunder Bay, Ont. NWOFTDU Tech. Rep. #30. 159 pp.
149. Duerr, W. A. 1985. Forestry economics as problem solving. Orange Student Bookstore, Inc., Syracuse, N.Y. Separately paginated chapters.

presumptuously assumes that people are willing to make investments in such low return projects.

If the amount of total production of tonnes of paper was to increase in the future as a result of the investments in intensive silviculture, the total value added to the economy would increase, but to determine the feasibility of this would require a comparison to alternative investment opportunities in other industries and options. As Anderson¹⁵⁰ pointed out:

“Capital can certainly seek alternative employment by the middle of the 21st century and the provision of jobs in the forestry sector means not the protection of present worker’s occupations in northern Ontario but rather the provision of these occupations for their grandchildren and great grandchildren who may or may not even live in the province much less be attracted to employment in the forest sector of the economy.”

b). Economic Analysis

In addition to the OMNR using value added in the economic analysis of silvicultural projects, they are inconsistent in the type of economic analysis methodology. Hynard¹⁵¹ used value added in efficiency analyses of silvicultural projects. Economic efficiency can be measured by three criteria:¹⁵²

“1. Economic efficiency is the choice of the outputs that maximize the total net return to a fixed budget and

150. **Anderson, F. J. 1979.** Ontario reforestation policy: benefits and costs. *Can Public Policy*. 5: 336—347.
151. **Hynard, P. P. 1984.** A decision-making model for forest managers using economic considerations. *Ont. Min. Nat. Resour.*, Toronto. 27 pp + appendices.
152. **Davis, L. S., and K. N. Johnson 1987.** Forest management. McGraw-Hill Book Co., Toronto. 790 pp.

other fixed inputs.

2. Economic efficiency is the choice of the input resources that minimizes the total cost of providing prespecified outputs.

3. Economic efficiency is the simultaneous choice of both the level of inputs and outputs or products that maximize total net return.”

In Hynard's first example, the first criteria was used to maximize the total net return by comparing two silvicultural operations. Value added was used as the expected value of the forest to be produced. In his second example, the third criteria was used in an attempt to find the level of inputs and outputs that maximize total net return. Again, value added was used as the value of the expected crop.

c). Forest Production Policy

The Forest Production Policy¹⁵³ used value added in the determination of B/C (benefit cost ratio) ratios to compare the value of different levels of intensive silviculture for the province to determine “how much money should be spent”. In their use of a form of B/C analysis, the third criteria, maximizing total net return was employed.

d). Crop Planning

Willcocks *et al.*¹⁵⁴ used value added of kraft pulp in a third

153. OMNR 1972. Forest production policy in Ontario. Ont. Min. Nat. Resour., Division of Forests. Toronto. 67 pp. (Exhibit 136.)

154. Willcocks, A. J. F. W. Bell, J. Williams, and P. N. Duinker 1990. A crop-planning process

criteria analysis of spacing of plantations to determine the maximum yield at lowest cost.

The second economic criteria is more appropriate for evaluating the economic feasibility of OMNR projects, as it minimizes the total cost of producing prespecified outputs. None of the above OMNR analyses were of that nature. Determination of the minimum cost necessary to produce a specified level of output would be more appropriate in the OMNR's mission to attain specific production targets.

e). Forest Production Policy Assumptions

In addition to the inappropriate use of value added in the forest production policy, the analysis contained other assumptions that are questionable:

i. The value per cunit varied for each of the propositions for managing for 2020. Significantly less value was ascribed to the natural regeneration option (see Table 6 — 3 on page 96).

ii. The natural regeneration option was not treated as a viable management alternative, but was termed as the "orderly liquidation of the remaining commercial forests in Ontario". A lower cost natural regeneration option would be more appropriate to determine the lowest cost to manage the forest to produce the specified target, a target that is within the LTSY (Long Term Sus-

tainable Yield) capability of the natural forest.

iii. The B/C analysis did not give a value for the management of the natural forest to compare to the other options. Table 6 — 4 on page 96 shows the higher B/C (infinitely high) that could be obtained using a natural regeneration option, (Option 1), even with the value added figures used for benefit. When a more realistic (for the time when the production policy was determined) stumpage figure of \$3.00 per cunit is used, the B/C ratio is much less for options other than the first one (see Table 6 — 5 on page 98). In this case, the B/C ratio was calculated in a standard manner.¹⁵⁵

iv. Unrealistic rotations of 50 years were presumed to be possible.¹⁵⁶ The rotations of 80 to 100 years recognized by the OMNR¹⁵⁷ would produce lower present values and B/C for all but option 1 (see Table 6 — 6 on page 99).

From the above information, it is apparent that it is not economically feasible to manage the majority of the forest lands in Ontario intensively.

155. **Davis, L. S., and K. N. Johnson** 1987. *Forest management*. McGraw-Hill Book Co., Toronto. 790 pp. (Exhibits 106 and 134).

156. **Anderson, F. J.** 1979. Ontario reforestation policy: benefits and costs. *Can Public Policy*. 5: 336—347.

157. **OMNR** 1987. *Class environmental assessment for timber*. Ont. Min. Nat. Resour., Toronto. Ont. p. 98. (Exhibit 4).

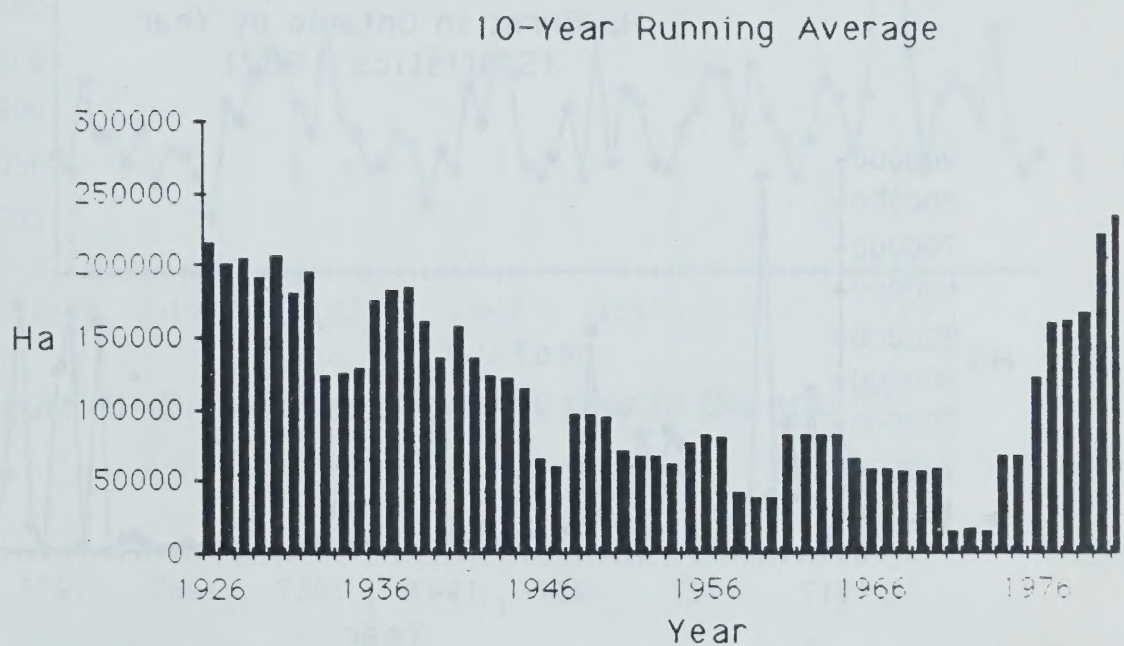


Figure 6—1 Ten-year running average of area burnt by fire in Ontario.¹⁵⁸

158. OMNR 1989. Statistics 1988-1989. Ontario Ministry of Natural Resources, Toronto, Ontario.117 pp. (see pp. 76-77.)

Ha Burnt in Ontario by Year
(Statistics 1987)

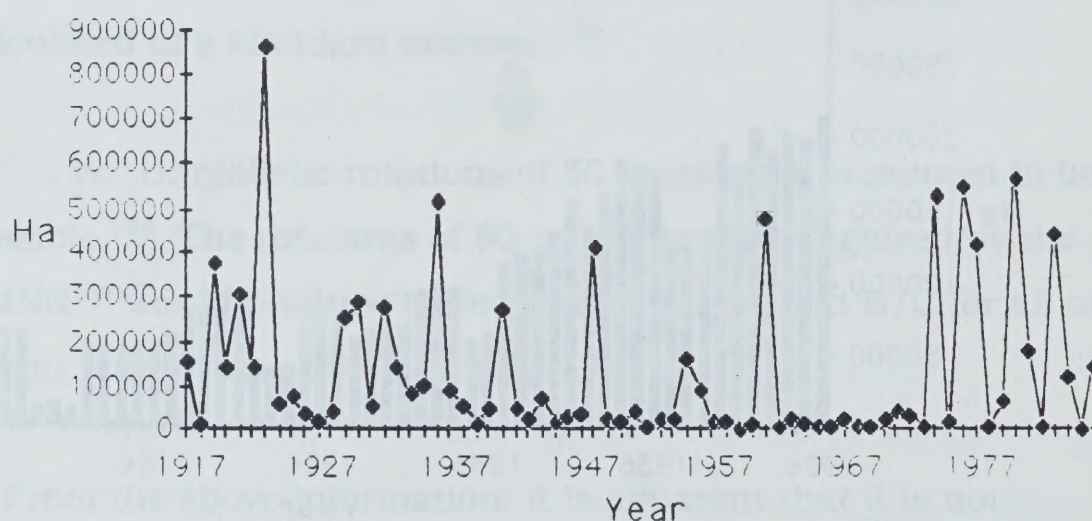


Figure 6—2. Hectares burnt per year in Ontario.¹⁵⁹

159. OMNR 1989. Statistics 1988-1989. Ontario Ministry of Natural Resources, Toronto, Ontario.117 pp. (see pp. 76-77.)

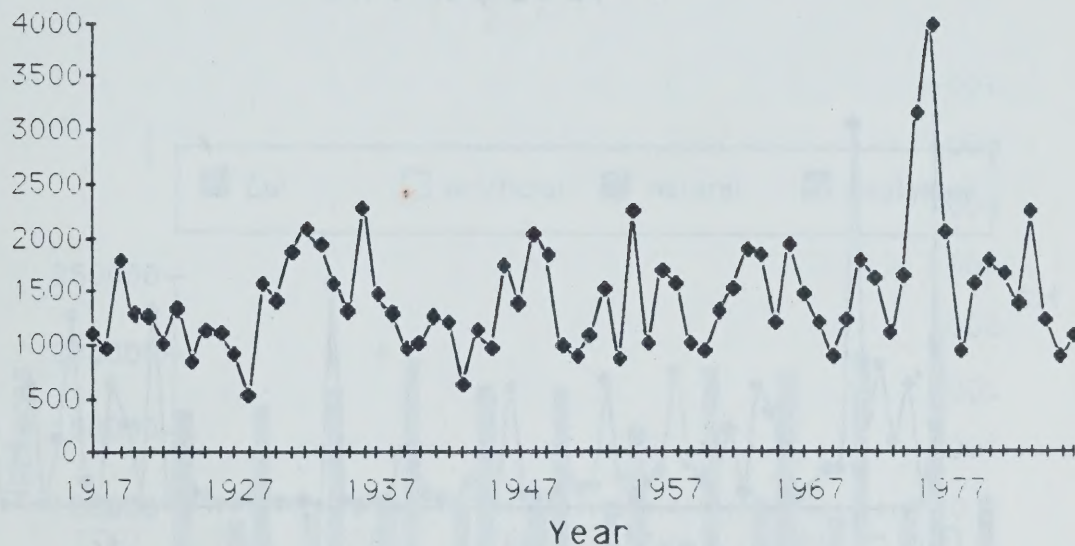


Figure 6—3. Number of fires by year in Ontario.¹⁶⁰

160. OMNR 1989. Statistics 1988-1989. Ontario Ministry of Natural Resources, Toronto, Ontario. 117 pp. (see pp. 76-77.)

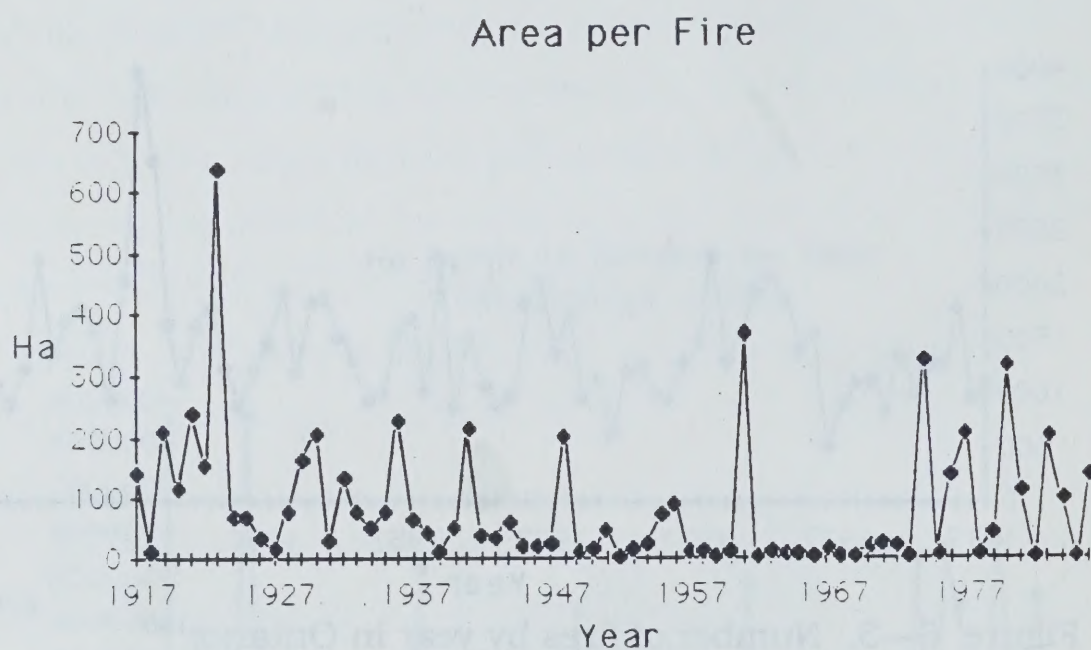


Figure 6—4. Area burnt per fire in Ontario.¹⁶¹

161. OMNR 1989. Statistics 1988-1989. Ontario Ministry of Natural Resources, Toronto, Ontario.117 pp. (see pp. 76-77).

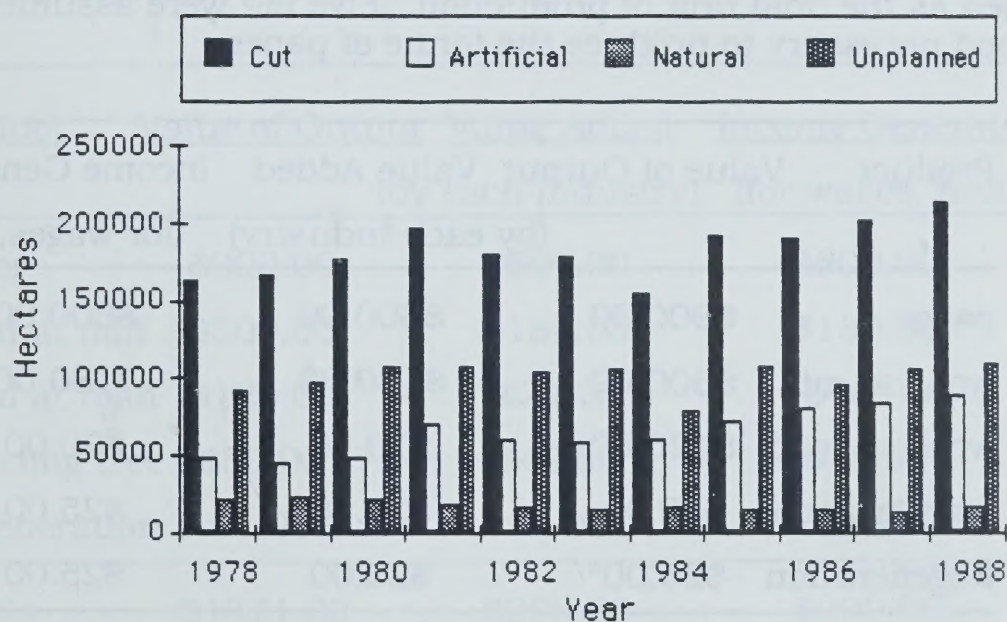


Figure 6—5. Area of Crown land cut in Ontario from 1978 to 1988, and the type of treatment received.¹⁶²

162. OMNR 1979-19899. Statistics 1988-1989. Ontario Ministry of Natural Resources, Toronto, Ontario.

Table 6—1 . Example of values at different levels of production assuming \$1000.00 per hectare is spent for intensive silviculture work. An end value of a tonne of paper (\$900.00) was used as the final unit of production. Five m³ were assumed to be wood necessary to produce the tonne of paper.

Product	Value of Output	Value Added (by each industry)	Income Generated (for wages, profit)
paper	\$900.00	\$600.00	\$600.00
wood at mill	\$300.00	\$180.00	\$180.00
wood at road	\$120.00	\$70.00	\$70.00
standing tree	\$50.00	\$25.00	\$25.00
Regeneration	\$25.00*	\$25.00	\$25.00
Totals	\$1395.00	\$900.00	\$900.00

* A yield of 200 m³/ha is assumed, thus the regeneration cost per ha is \$1000.00 regeneration divided by the 200 m³ per ha to give \$5.00/m³. For 5 m³ the regeneration cost is \$5.00 times 5 m³ = \$25.00. The regeneration cost of \$1000.00 includes nursery stock cost and is less than the estimates \$1153.31 to \$1230.41 per ha for regeneration noted by Willcocks *et al.*¹⁶³

163. Willcocks, A. J. F. W. Bell, J. Williams, and P. N. Duinker 1990. A crop-planning process for northern Ontario forests. Ont. Min. Nat. Resour., Northwestern Ontario Forest Technology Development Unit, Thunder Bay, Ont. NWOFTDU Tech. Rep. #30. 159 pp. (p. 107).

Table 6—2. Example of values at different levels of production assuming \$20.00 per hectare is spent for extensive silviculture work. An end value of a tonne of paper (\$900.00) was used as the final unit of production. Five m³ were assumed to be wood necessary to produce the tonne of paper.

<u>Product</u>	<u>Value of Output</u>	<u>Value Added</u> (by each industry)	<u>Income Generated</u> (for wages, profit)
paper	\$900.00	\$600.00	\$600.00
wood at mill	\$300.00	\$180.00	\$180.00
wood at road	\$120.00	\$70.00	\$70.00
standing tree	\$50.00	\$49.00	\$49.00
Regeneration	\$1.00*	\$1.00	\$1.00
Totals	\$1371.00	\$900.00	\$900.00

* A yield of 100 m³/ha is assumed, thus the regeneration cost per ha is \$20.00 regeneration divided by the 100 m³ per ha to give \$0.20/m³. For 5 m³ the regeneration cost is \$0.20 times 5 m³ = \$1.00.

Table 6—3. Average value of a cunit of wood used in the 1972 forest production policy. Average values were determined by dividing the Anticipated Value Added by the Anticipated Harvest at 2020.¹⁶⁴

Policy Option	Anticipated Harvest at 2020 (MM cunits)	Anticipated Value Added (\$MM)	Average Value/cunit (\$)
1	1.3	101	77.69
2	4	451	112.75
3	6.2	736	118.71
4	12	1488	124.00
5	16	2006	125.38

Note:

Policy Option 1 was to make no investment, and to preside over the orderly liquidation of the remaining commercial forests in Ontario. Non-planned natural regeneration would be used to regenerate the forest.

Policy Option 2 was to maintain the present expenditure level of 8.8 million dollars which regenerates about 136,000 acres a year.

Policy Option 3 was to maintain the present level of harvest by regenerating 376,000 acres a year.

Policy Option 4 was to produce sufficient timber to meet the projected demand of 12.0 million cunits by 2020.

Policy Option 5 was to produce sufficient timber to meet a higher proportion of projected world demand.

164. OMNR 1972. Forest production policy in Ontario. Ont. Min. Nat. Resour., Division of Forests. Toronto. 67 pp. (Exhibit 136).

Table 6-4. The Present Net Worth (PNW) and Benefit Cost Ratio (B/C) are shown for the different policy options of the 1972 OMNR forest production policy (OMNR 1972). Value added was used to determine the Anticipated Value at 2020.

	1	2	3	4	5	6
Policy Option	Interest rate	Investment (\$MM)	Anticipated value added at 2020 (\$MM)	PV of anticipated value added at 2020 (rotation=50) (\$MM)	PNW (PV of Benefits Minus PV of Costs) (\$MM)	B/C
1	4%	0	101	14.21	14.21	∞
2		8.8	451	63.46	54.66	6.21
3		15.3	736	103.56	88.26	5.77
4		29.8	1488	209.38	179.58	6.03
5		44.5	2006	282.27	237.77	5.34
1	7%	0	101	3.43	3.43	∞
2		8.8	451	15.31	6.51	0.74
3		15.3	736	24.99	9.69	0.63
4		29.8	1488	50.51	20.71	0.70
5		44.5	2006	68.10	23.60	0.53
1	10%	0	101	0.86	0.86	∞
2		8.8	451	3.84	-4.96	-0.56
3		15.3	736	6.27	-9.03	-0.59
4		29.8	1488	12.68	-17.12	-0.57
5		44.5	2006	17.09	-27.41	-0.62

Table 6-5. The Present Net Worth (PNW) and Benefit Cost Ratio (B/C) are shown for the different policy options of the 1972 OMNR forest production policy (OMNR 1972). A stumpage of \$3.00 per cunit was used to determine the Anticipated Value at 2020.

Policy Option	1	2	3	4	5	6
	Interest rate	Investment (\$MM)	Anticipated Stumpage (\$3.00/cunit -) (\$MM)	PV of anticipated value added at 2020 (rotation=50) (\$MM)	PNW (PV of Benefits Minus PV of Costs) (\$MM)	B/C
1	4%	0	3.9	0.55	0.55	∞
2		8.8	12	1.69	-7.11	-0.81
3		15.3	18.6	2.62	-12.68	-0.83
4		29.8	36	5.07	-24.73	-0.83
5		44.5	48	6.75	-37.75	-0.85
1	7%	0	3.9	0.13	0.13	∞
2		8.8	12	0.41	-8.39	-0.95
3		15.3	18.6	0.63	-14.67	-0.96
4		29.8	36	1.22	-28.58	-0.96
5		44.5	48	1.63	-42.87	-0.96
1	10%	0	3.9	0.03	0.03	∞
2		8.8	12	0.10	-8.70	-0.99
3		15.3	18.6	0.16	-15.14	-0.99
4		29.8	36	0.31	-29.49	-0.99
5		44.5	48	0.41	-44.09	-0.99

Table 6-6. The Present Net Worth (PNW) and Benefit Cost Ratio (B/C) are shown for the different policy options of the 1972 OMNR forest production policy (OMNR 1972). Value added per cunit was used to determine the Anticipated Value at 2020, but a more realistic rotation of 100-years was used instead of 50 years. B/C ratios less than one are not a good investment.

Policy Option	1 Interest rate	2 Investment (\$MM)	3 Anticipated value added at 2020 (\$MM)	4 PV of anticipated value added at 2020 (rotation=100) (\$MM)	5 PNW (PV of Benefits Minus PV of Costs) (\$MM)	6 B/C
1	4%	0	101	2.00	2.00	∞
2		8.8	451	8.93	0.13	0.01
3		15.3	736	14.57	-0.73	-0.05
4		29.8	1488	29.46	-0.34	-0.01
5		44.5	2006	39.72	-4.78	-0.11
1	7%	0	101	2.00	2.00	∞
2		8.8	451	8.93	0.13	0.01
3		15.3	736	14.57	-0.73	-0.05
4		29.8	1488	29.46	-0.34	-0.01
5		44.5	2006	39.72	-4.78	-0.11
1	10%	0	101	2.00	2.00	∞
2		8.8	451	8.93	0.13	0.01
3		15.3	736	14.57	-0.73	-0.05
4		29.8	1488	29.46	-0.34	-0.01
5		44.5	2006	39.72	-4.78	-0.11

7. NATURAL REGENERATION AND ECOLOGICAL CONCERNS.

There is no doubt that harvesting operations affects the forest; including the macro and micro climate, water, soil, wildlife, flora, and vegetation.¹⁶⁵ What is not known, is the direct impact of different harvesting operations, at different times of the year, of different sizes, on the variety of site and forest types of the area of the undertaking. Specific research for each type of site and the numerous associated variables is lacking. If harvesting is to occur in an area, the detrimental effects to the environment may be minimized by using smaller cuts and natural regeneration methods as opposed to the larger cuts and possible silvicultural treatments associated with present harvests.

A forest manager making a decision to harvest an area is implementing a change to that area that if detrimental may not be corrected within a rotation. Existing information from other areas must be interpreted as to its most likely effect in the area of the undertaking. The forest manager must rely on information from:

- a). Past experience.
- b). Past experience of other individuals for the same or similar areas.

165. **Weetman, G. F. 1983.** Forestry practices and stresses on Canadian forest land. *in* Stress on Land, Folio No. 6, Canadian Government Publication Centre, Supply and Services, Ottawa, Ontario. pp 260—301. (Included in OMNR Statement of Evidence Panel X).

c). Published research that is precise for specific areas, but must be extrapolated to other management areas.

d). Opinions of specialists and summaries of documented information of published reports and experiences.

The information available may be conflicting in its nature, thus complicating the process of determining the effect of a decision. However, we do know that certain principles are universal in their effect, but we may not know the magnitude of that effect for a particular area. For example, we know that being involved in a car crash at 100 km/hr has a high probability of causing severe injury or death. The actual results of the crash will depend upon numerous factors that may be involved such as; was a seat belt being worn, was it a head on crash into a transport or a Volkswagen, or were you in the back or front seat, what model of car you were driving and other factors. The general principle we know is that the results are likely to be unfavourable. Similarly, there are general principles that apply to the forest ecosystem. The manager of the forest resource must make a decision based on the best evidence available, similar to the way a person would consult several physicians concerning a medical problem before making a decision as to what action to take.

Based on existing information, the most important ecological reasons for favouring natural regeneration over artificial regeneration are the retention of species diversity and productivity of the site for all living organisms of the forest.

1. Regeneration

A fundamental issue is the effect of clearcutting on the forest. Both the industry and the OMNR maintained that clearcutting emulates the regenerating capabilities of fire in the forest.¹⁶⁶ The basis of the argument is centered on the opinion that harvesting creates the site conditions necessary for the new crop of trees to become established. **If this was entirely true, it should not be necessary to regenerate artificially.**

A basic feature of fires in forest stands in the Boreal forest is that they leave a mosaic of vegetation.^{167,168} A. D. Revill Associates¹⁶⁹ summarized this effect:

"It is important to keep the overall Boreal Forest mosaic in mind. Different intensities of fires will determine to what extent vegetative plant material is left for sprouting, suckering, or seed source. Different frequencies may totally change the vegetative type; for example 2 fires 45 years apart in jack pine will regenerate jack pine, but two fires three years apart in jack pine would have a totally different effect, probably perpetuating aspen. Also important are topography, exposure, season, extent and quality of fuels on the forest floor, presence of permafrost, the type of fire, and the type of forest burned. The interspersation of forests of many different ages into a widespread mosaic is probably a much more important overall feature of the Boreal Forest than is the post-fire vegetation within any particular part

166. OMNR 1989. Statement of Evidence, Panel 11. and OFIA/OLMA 1989. Statement of Evidence No. 6.

167. Heinselman, M. L. 1981. Fire succession in the conifer forests of Northern North America pp. 374—405 (p. 391), in *Forest Succession Concepts and Application*, Springer-Verlag, New York. 517 pp.

168. Larsen, J. A. 1980. The boreal ecosystem. Academic Press, Toronto. 500 pp. See page 329.

169. Revill, A. D. Associates 1978. Ecological effects of fire and its management in Canada's national parks. Vol 1. Research report prepared for Natural Resources Division, National Parks Branch, Parks Canada, Ottawa, Ontario. 191 pp. (p. 63).

of it. It is this patchwork that provides for a dynamic ecosystem much richer in plants and animals than it would be otherwise. If fire suppression were to be particularly efficient and long lasting, it is this natural mosaic feature that we should be most concerned about losing. Since there is no real natural precedent for such a condition, we can only guess at what might happen where fire is excluded from a fire dependent forest network. Kelsall *et al* (1977) speculates that the trend would be towards a relatively sterile and homogeneous climax of conifers, or, on permafrost, to a black spruce forest that ultimately develops into many sphagnum bogs. The less efficient disturbances such as wind, and disease would have to take the place of fire to perform the role of cycling the system again."

This mosaic of the boreal forest can be caused by two factors, small fires and skipped areas.¹⁷⁰ The mosaic created by fire is different than clearcutting, as fires do not selectively pick older age classes to burn. A fire can burn through a variety of age-classes, creating a burn area of one age-class with surviving different age-classes scattered throughout it, and surrounded by a variety of age-classes. In addition to the fact that fire can leave a mosaic of vegetation, it also leaves living individual trees or stands with their cones throughout the burn area.¹⁷¹ As the cones of jack pine are serotinous and those of black and white spruce semi-serotinous, they open and disperse their seed over the burn after the fire.

A critical condition for regenerating spruce and jack pine after a fire is the distance the seed can travel. For black spruce:

170. Heinselman, M. L. 1981. Fire succession in the conifer forests of Northern North America pp. 374—405 (p. 400), in *Forest Succession Concepts and Application*, Springer-Verlag, New York. 517 pp.
171. Larsen, J. A. 1980. *The boreal ecosystem*. Academic Press, Toronto. 500 pp. See page 329.

"Seed dispersal may be expected to be effective for only two or three tree heights.",¹⁷²

while for jack pine:

"The effective range of seed dissemination, as measured by established seedlings, is about two tree heights, although it is low beyond one tree height."¹⁷³

Consequently after a fire, the area burned may become regenerated with jack pine and black spruce if seed is available from trees still alive or from the cones of killed trees that were opened by the fire. The lighter wind borne seed of both aspen and white birch may seed in from a greater distance than the conifers.

Thus, fire not only prepares the site for regeneration of species; but also opens the cones of conifers throughout the burn area to allow them to seed the area within their seed dissemination range. On the other hand, the practice of large clearcuts and increasing use of full tree logging not only remove most of the seed from the area, they also create a distance larger than the effective seed dissemination range of the conifers.

Large clearcuts require the more expensive option of site preparation and planting or artificial seeding.¹⁷⁴ The success of these expensive operations has not been impressive. Surveys of recently established plantations appear to be successful in the

172. **USDA 1965.** *Silvics of forest trees of the United States.* U. S. Dept. of Agr., Forest Service, Washington, D. C., Agr. Handbook No. 271. 762 pp. (p. 292).

173. **USDA 1965.** *Silvics of forest trees of the United States.* U. S. Dept. of Agr., Forest Service, Washington, D. C., Agr. Handbook No. 271. 762 pp. (p. 342).

174. **Farmer, R. E., P Knowles, and W. H. Parker. 1982.** Genetic resources of the North American Boreal forest. pp. 40—51. *in* Resources and Dynamics of the Boreal Zone. Proceedings of a Conference, Thunder Bay, Ontario. 544 pp.

short term,¹⁷⁵ but the OMNR has poor records of regeneration since 1973. Prior to 1973:

“satisfactory regeneration is achieved on 52% of jack pine; 41 percent of white and 23 percent of black spruce; 2% of white pine and 8% of red pine areas”.^{176,177}

Long term results of the SOARS^{178,179} reports for these early plantations are more depressing.

The reporting method used in the SOARS reports are somewhat misleading as they are not classed as to successfully regenerated to the species that was planted or seeded:

“In the assessment of area in this study, the precise management objective in regeneration was not usually known.”¹⁸⁰

At the time the trees surveyed were planted or seeded, the objective of regenerating areas by artificial regeneration was to obtain the planted species back on the area to form the new working group of that species.¹⁸¹⁻¹⁸³ Figure 7 — 1 on page 114 shows

175. **OFIA/OLMA 1989.** Statement of evidence Panel 8. Renewal of the Timber Resource. Environmental Assessment Hearings, Toronto, Ontario. 159 pp. + appendices. (see p.124).
176. **OMNR 1989.** Statement of Evidence Panel IV, Environmental Assessment Hearings, Thunder Bay, Ontario. 278 pp. (p. 131).
177. **OMNR 1974.** Survival and growth of tree plantations on Crown lands in Ontario. Ont Min. Nat. Resour., Division of Forests, Toronto, Ontario. 17 pp. (pages include subpages).
178. **OMNR 1989.** Survey of artificial regeneration in northern Ontario, Statement of Evidence Panel IV, Environmental Assessment Hearings, Thunder Bay, Ontario. 278 pp. (pp. 221—248).
179. **OMNR 1989.** Survey of artificial regeneration in northern Ontario, Environmental Assessment Hearings, Thunder Bay, Ontario. 22 pp. (Exhibit 553).
180. **OMNR 1989.** Survey of artificial regeneration in northern Ontario, Statement of Evidence Panel IV, Environmental Assessment Hearings, Thunder Bay, Ontario. 278 pp. (p. 238).
181. **OMNR 1969.** Management plan for the Northern management unit, Ont Min. Nat. Resour., Kapuskasing, Ontario. not paginated.
182. **OMNR 1975.** Management plan for the Hearst management unit, Ont Min. Nat. Resour., Kapuskasing, Ontario. 76 pp.
183. **OMNR 1969.** Management plan for the Temagami management unit. Ont Min. Nat. Resour., Temagami, Ontario. 106 pp.

the percent success of the areas measured in the SOARS study, when success is based on present stocking standards. Stocking standards in the late 1960's and 70's were more demanding, 70% stocking to the desired species, thus the results would probably be more abysmal if the earlier standards were used.

The confusing description of the results used by SOARS is similar to the manner that the harvesting of white pine and its subsequent regeneration in the Temagami District was portrayed:

"When the Temagami Reserve was created with its large stands of pine, the pressure to log was great and it was permitted except for islands and the Skyline Reserve on the mainland which by regulation in 1905 were excluded. Their result has been that with little management input over a period of nearly 80 years, the cutovers have regenerated variously depending on time, vagaries of weather, occurrence of seed crops and soil conditions, while the stands in the islands and skyline reserves are in various stages of transition from pine to other species such as maple and balsam fir (Gilbert 1978)."¹⁸⁴

This was interpreted by Weetman¹⁸⁵ to mean:

"In the following 80 years the cut areas have regenerated naturally, partly to pine and other species, while the islands and the skyline reserves are in various stages of transition from pine to other species such as maple and balsam fir (Armson, 1981). In this case, logging has thus been an important factor in maintaining a high pine component in the forest."

184. **Armson, K. A. 1981.** Space, time and perspectives in forestry. University of Alberta, Forest Industry Lecture Series No. 8, Edmonton, Alberta.

185. **Weetman, G. F. 1983.** Forestry practices and stresses on Canadian forest land, *in* Stress on Land, Folio No. 6, Canadian Government Publication Centre, Supply and Services, Ottawa, Ontario, pp 260—301. (see p. 266)

Data for the management units of the Temagami District indicate that white pine has not regenerated back on the cutovers.¹⁸⁶ Figure 7 — 2 on page 115 shows the age-class distribution of the white pine working group as determined from the 1980—1990 management plan for the Temagami management unit.¹⁸⁷ If the white pine had regenerated in the cutover, the younger age-classes would have considerably more area than indicated by the figure. Over 4000 ha of the older growth of the figure is in the Skyline Reserve.

The Temagami Management Plan gives a correct interpretation of the regeneration situation when it states:

“This prolonged period of high-grading has left much of the forest with trees of very poor quality. Stands contain a variety of age classes and species, and reduced stocking.”

In addition to the requirement for a seed source, regeneration of an area to the same species that were harvested requires site conditions that favour those species. Through the process of succession, a variety of species occupy it at different time periods. Harvesting the area causes it to revert to an earlier stage in the successional process. Obtaining the desired species requires leaving a site that is more suitable to the desired species than others.¹⁸⁸ Wildfires, harvesting, and scarification methods can be

186. **Benson, C.A., H. Cumming, H. Akervall, and W. Carmean 1989.** The need for a land stewardship, holistic resource management plan for N'Daki Menan. Report prepared for the Teme-augama Anishnabai, Bear Island, Temagami, Ont. 114 pp. + appendices.
187. **OMNR 1985.** Forest Management Plan for the Temagami Crown Management Unit, Ont. Min. of Nat. Resour., Temagami, Ont. 213 pp.
188. **Kimmins, J. P. 1987.** Forest Ecology. Macmillan Publishing Company, New York. 531 pp. (pp. 480—481).

detrimental to the site¹⁸⁹ and cause it to revert to an earlier stage than desired in the successional sequence.¹⁹⁰ Extreme examples are the Sudbury and Wawa areas, where a combination of fumes, harvesting and fire, have created a bleak landscape (See Photo 401c). Rather than try to emulate the effect of wildfire on an area to obtain the same forest, the objective of regeneration should be directed to obtain the site conditions favourable for the species desired, avoiding the detrimental effects of fire.

Natural regeneration, with its smaller size of clearcuts, meets the requirement for providing the seed source. Moreover, the site conditions necessary for the desired species may be satisfied. Jeglum and others¹⁹¹⁻¹⁹³ have found that black spruce may be successfully regenerated on a variety of sites with and without light scarification. Generally, there has been a paucity of research on natural regeneration methods compared to examination of the more expensive alternatives of intensive management. In some cases, the research has been carried out but not implemented. For example, in 1932 Leslie¹⁹⁴ found selection cutting was better for white pine regeneration than clear cutting, yet clearcutting of white pine was recommended and carried out well after this

189. **Jeglum, J. K. 1989.** Alternate-strip cutting to regenerate black spruce: why aren't we using it more? 21 pp. in *Proc. Workshop Tools For Site Specific Silviculture in Northwestern Ontario*. OMNR Tech. Devel. Unit, Thunder Bay, Ontario. In press.
190. **Kimmins, J. P. 1987.** *Forest Ecology*. Macmillan Publishing Company, New York. 531 pp.
191. **Jeglum, J. K. 1989.** Alternate-strip cutting to regenerate black spruce: why aren't we using it more? 21 pp. in *Proc. Workshop Tools For Site Specific Silviculture in Northwestern Ontario*. OMNR Tech. Devel. Unit, Thunder Bay, Ontario. In press.
192. **Jeglum, J. K. 1989.** Modified harvesting to promote natural regeneration of black spruce. in *The Ecology and Silvics of Boreal Spruces*. Symposium and field meeting of IUFRO Working Group S1.05-12, Newfoundland. In press.
193. **Fraser, J. W., V. F. Haavisto, J. K. Jeglum, T. S. Dal, and D. W. Smith. 1981.** Black spruce regeneration on strip cuts and clearcuts in Nipigon and Cochrane areas of Ontario. Dep. Environ., Can. For. Serv., Sault Ste. Marie, Ontario. Report O—X—246. 33 pp. (Exhibit 497).
194. **Leslie, A. P. 1932.** Synopsis of report on the forest regeneration survey Algonquin Park Ontario 1931. Ont. Forestry Branch, Toronto, Ontario. 9 pp.

research.¹⁹⁵

Research into natural regeneration method deserves more study especially as it is the predominant method used by method or default to regenerate the majority of the cutover in Ontario, yet very little of this is through modified cutting.¹⁹⁶ Although the OMNR does not have provincial silvicultural data available, they did assemble data for eight districts.¹⁹⁷ This data indicated, for the districts that had information, 87% of the areas regenerated naturally had satisfactory stocking compared to 76% for the areas treated artificially. Natural regeneration methods that have been applied on FMA's have worked¹⁹⁸ (see Figure 7 — 3 on page 117), and even areas that were not harvested in the most favourable manner to promote natural regeneration satisfactory regeneration has occurred.^{199,200} Implementation of modified cut by industry for natural regeneration produced successfully stocked areas of desired species after five years,²⁰¹ and it is expected that the results for these areas will improve. Modified cuts in the Kiashke management unit have obtained successful natural regeneration.²⁰² More research on natural regeneration technology

195. **Benson, C.A., H. Cumming, H. Akervall, and W. Carmean 1989.** The need for a land stewardship, holistic resource management plan for N'Daki Menan. Report prepared for the Teme-Augama Anishnabai, Bear Island, Temagami, Ont. 114 pp. + appendices.
196. **OMNR 1989.** Answer to interrogatory question #8, Panel 11. Environmental Assessment Hearings, Thunder Bay, Ontario. 2 pp.
197. **OMNR 1989.** Answer to interrogatory question #15, Panel 11. Environmental Assessment Hearings, Thunder Bay, Ontario. Not paginated.
198. **OFIA/OLMA 1990.** Panel 8 Renewal. Environmental Assessment Hearings, Toronto, Ontario. 159 pp + appendices. (pp. 124).
199. **OMNR 1987.** Forest management agreements. Second five-year review 1981-1986. Ont. Min. Nat. Resour., Toronto, Ontario. 93 pp. (Exhibit 68).
200. **OMNR 1989.** Forest management agreements. Fourth five-year review 1983-1988. Ont. Min. Nat. Resour., Toronto, Ontario. 72 pp.
201. **OFIA/OLMA 1990.** Panel 8 Renewal. Environmental Assessment Hearings, Toronto, Ontario. 159 pp + appendices. (pp. 124).
202. **Fahlgren, J.E.J. 1985.** Final report and recommendations, the Royal Commission on the Northern Environment. Ontario Ministry of the Attorney General, Toronto, Ontario. separately

would be advantageous, but improved results may be obtained if the advice of Weetman²⁰³ is followed. He advised:

“we suggest that foresters should become more observant in the forest. It is our experience that careful observation of natural regeneration and successional trends can help a forester to build a great deal of local knowledge about regenerating stands.”

Natural regeneration requires that a seed source be available. The increasing use of full-tree harvesting removes the cones from the harvested area. For large clearcuts, the removal of the seed source can be particularly detrimental as it decreases the chances of the desired species for regenerating the area. Smaller cuts can help alleviate this problem by keeping the cut area within the range of the natural range of seed dispersal.

An objection oft raised to the concept of implementing smaller clearcut and modified cuts for the purposes of natural regeneration, is that the logging costs will increase. This may be true in some cases, but not always so.²⁰⁴ Studies in Ontario on the increase in logging costs have been limited in the scope of operations they cover; they examine the increase in harvesting costs, but not the overall reduction in harvesting and silvicultural costs.²⁰⁵⁻²⁰⁷ In addition, they make the assumption that the last

paginated chapters. (see p. 5-25).

203. **Weetman, G., and A. Vyse. 1990.** Natural regeneration. 118-129. in *Regenerating British Columbia's Forests*. Univer. of B.C. Press, Vancouver, B.C. 372 pp.

204. **Begin, J. 1986.** Modification of harvesting techniques to foster natural regeneration. CPPA. Canadian Forest Industries, WSI 2961 (bi) (F-4- ODC 231.49. Nov. pp. 31-40.

205. **Ketcheson, D. E. and J. H. Smyth. 1978.** Impact of strip cutting on logging costs. Ontario Forest Research Newsletter. Summer.

206. **Ketcheson, D. E. 1979.** A study of the cost of strip cutting black spruce stands in northern Ontario. Can. For. Serv., Sault Ste. Marie, Ontario. Report O-X-301. 23 pp.

207. **Ketcheson, D. E. 1982.** The impact of strip cutting on logging road costs. Can. For. Serv., Sault Ste. Marie, Ontario. Report O-X-263. 19 pp. + appendices.

strip will need to be artificially regenerated instead of waiting for the first cut strips to be mature enough to naturally regenerate the last cut strip.²⁰⁸ The Forest Operations Institute of Sweden investigated the effect of the size of an area on felling, extraction, and scarification costs. For felling and extraction, the costs tend to level off after 1000 m³/ha.²⁰⁹ With 100 m³/ha, the cut area could be 10 ha in size and harvested at a cost similar to a larger area. With 200 m³/ha, the cut area could be 5 ha in size and harvested at a cost similar to a larger area. Scarification costs increased for an area larger than 5 ha. More importantly, silvicultural costs can be considerably cheaper with natural regeneration than artificial methods.²¹⁰

Ontario lags behind other provinces and forest producing countries of the world in limiting the size of clearcuts. British Columbia has clearcuts that range between 20 to 80 ha in size.²¹¹ In Alberta, the cut may be in blocks or strips. The size of blocks shall average no more than 60 ha, but can vary up to 100 ha in size for pine and hardwoods. For spruce, the cut blocks may be in patches up to a maximum of 24 ha or strips up to a maximum of 32 ha with no part of the cutover further than 150 metres from the seed source. Blocks similar to the size for pine may be cut if the intent of the operator is to regenerate the area at his cost.

- 208. **Johnson, D. J. and J. H Smyth. 1988.** Alternate strip cutting in upland black spruce. VI. Harvesting and renewal costs of strip cutting relative to those of clearcutting. *For. Chronicle*. 64:1. pp. 59—63.
- 209. **Remrod, J. K. 1990.** Clearcutting and silviculture - the Swedish example. pp E123—E127 in Preprint Book, Woodlands Section, 71st Annual Meeting, Canadian Pulp and Paper Assoc. Montreal, Quebec: 127 pp.
- 210. **Jeglum, J. K. 1989.** Alternate-strip cutting to regenerate black spruce: why aren't we using it more? 21 pp. in *Proc. Workshop Tools For Site Specific Silviculture in Northwestern Ontario*. OMNR Tech. Devel. Unit. Thunder Bay, Ontario. In press.
- 211. **Holden, H. 1990.** Chain-saw massacre or healthy forest? *Globe and Mail*, May 16.

Harvesting of the second or third block and strip may not occur until the regeneration in the cut block has reached 2 metres in height, about 20 years old for conifers.²¹² The forest production areas of Québec have the maximum size of clearcuts limited to less than 250 ha. Reserves of timber, at least 60 m wide are to be left between clearcut areas less than 150 ha in size, while 100 m reserves are required for larger clearcuts. Reserves may not be harvested until the cutover has regeneration at least two m in height.²¹³ Clearcuts in Nova Scotia are limited to 50 ha in size.

In Finland, the clear cut areas are between 2 and 20 ha in size. Sweden has average clearcuts that range from 1.8 to 27.1 ha in size.²¹⁴

Clearcuts in the United States on Federal forest land vary according to the detailed management prescriptions for an area. The usual prescriptions are for clearcuts of less than 40 ha and separated by stands at least 10 ha in size, although cuts of 200 ha may be prescribed in some cases.²¹⁵ Their National Forest Management Act 1976 limits the size of most clearcuts from 16 to 40 ha, depending upon the forest type.²¹⁶

212. **Alberta 1989.** Alberta timber harvest planning and operating ground rules. Forestry, Lands and Wildlife, Edmonton, Alberta. 600 pp. (p. 22).

213. **Québec 1989.** Modalités d'intervention en milieu forestier. Ministère de l'Énergie et des Ressources, Québec. 81 pp.

214. **Remrod, J. 1990.** Clearcutting and silviculture - the Swedish example. pp E123—E127 in Preprint Book, Woodlands Section, 71st Annual Meeting, Canadian Pulp and Paper Assoc. Montreal, Quebec. 127 pp.

215. **USDA Forest Service 1985.** Draft proposed land and resource management plan. Superior National Forest. U.S. Forest Service, Duluth, Minn. 5 separately paginated chapters + appendices. (p. 4-129 and 4-43).

216. **Weetman, G. F. 1983.** Forestry practices and stresses on Canadian forest land. in Stress on Land. Folio No. 6, Canadian Government Publication Centre, Supply and Services, Ottawa, Ontario. pp 260—301. (p. 286). Found in Exh. 416A, pp. 323-369.

There is no doubt that natural regeneration can be effective now, and could probably be improved with more research in that area. Implementation of smaller cut size necessary for natural regeneration is technically feasible in other areas of Canada and the world and should be applicable to Ontario. Additionally, the smaller cuts associated with natural regeneration would have more chance of satisfying the 46% of Canadians strongly opposed to clearcutting and the 25% that somewhat disapprove of clearcutting.²¹⁷

217. Forestry Canada 1989. Public opinion survey of Canadians regarding forest management.

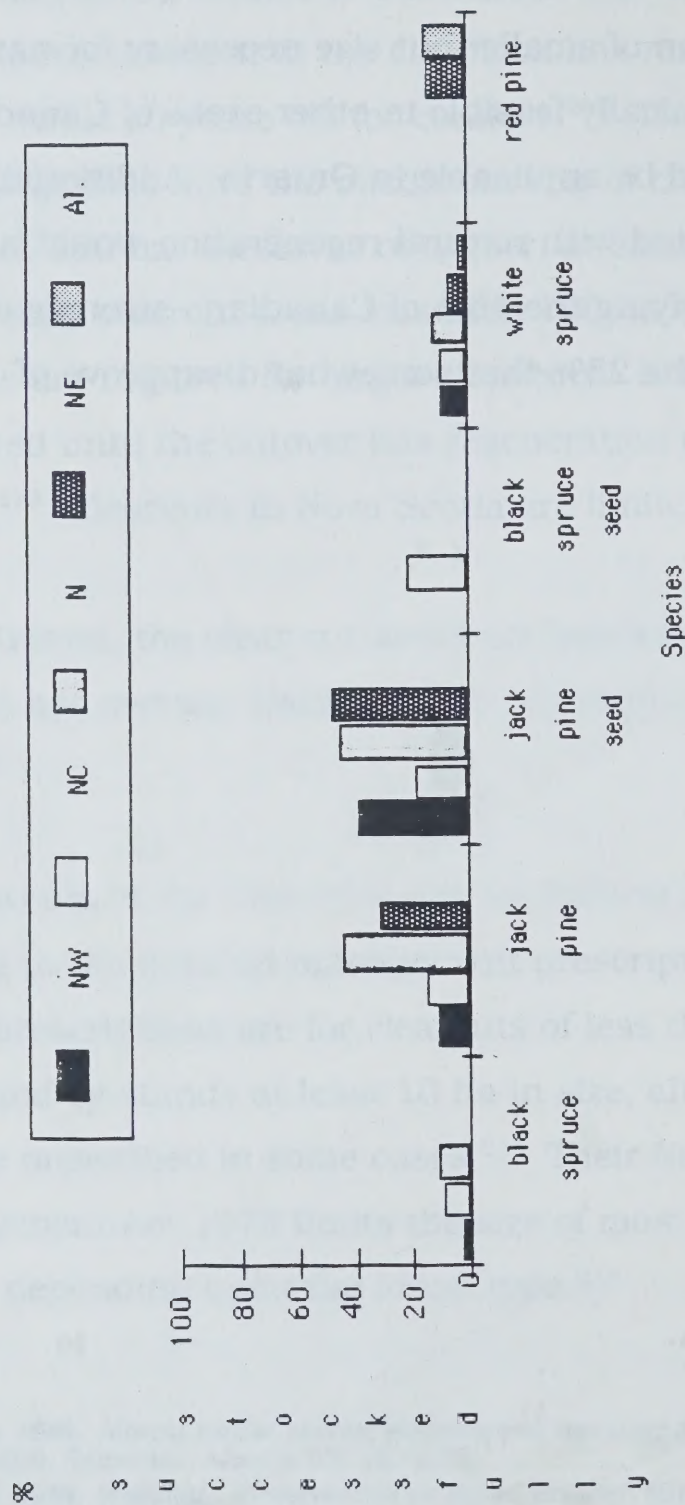


Figure 7-1. Percent success of areas measured in the SOARS reports. Success is based on the areas that have regenerated to the standards of growth and density for the species planted or seeded to be included in the MAD base. NW, NC, N, NE, AL represent the Northwestern, Northcentral, Northern, Northeastern, and Algonquin regions respectively.

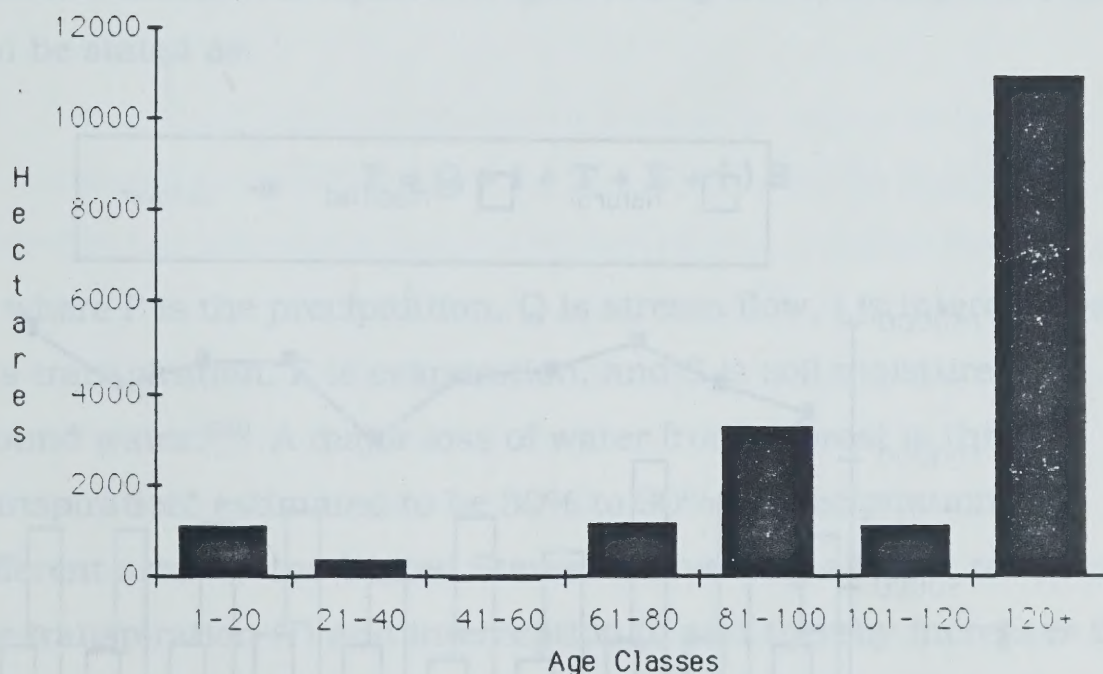


Figure 7—2. Age-class distribution of the Temagami Crown Management Unit. Note the lack of area in the younger age-classes corresponds with the start of cutting in the area, about 70 years ago.

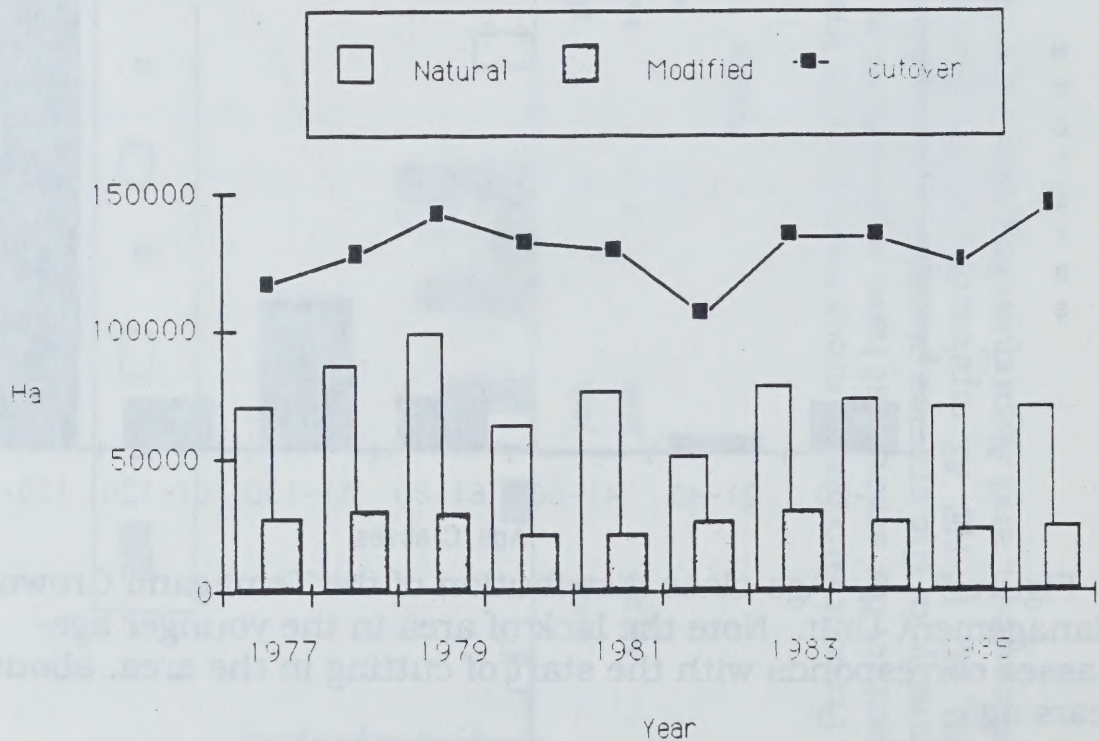


Figure 7—3 . Cutover, natural regeneration, and modified harvest area for the Northern, North Central, and Northwestern Regions of Ontario.²¹⁸

218. OMNR 1989. Response to interrogatories for Panel XI to Forests for Tomorrow.

2. Water

Harvesting operations can have detrimental effects on water quality.²¹⁹ As detailed information regarding the effect of harvesting methods on the hydrology of specific areas in Ontario is limited, general principles must be resorted to to interpret the possible effects. An equation representing the hydrological cycle can be stated as:

$$P = Q + I + T + E + (-) S$$

where P is the precipitation, Q is stream flow, I is interception, T is transpiration, E is evaporation, and S is soil moisture and ground water.²²⁰ A major loss of water from a forest is through transpiration, estimated to be 30% to 90% of precipitation in different areas of the United States. Harvesting a forest reduces the transpiration (T) and interception (I) and thereby increases the amount of water in the other components of the equation. The more of the forest canopy that is removed, the larger the increase in water yield (Q).²²¹ The larger the water yield, the greater the surface erosion and sedimentation. Application of herbicides can increase stream flow because of the transpiration loss from killed or suppressed vegetation. Removing understory vegetation by herbicide treatments can increase stream flow up to 61%.²²² Scar-

219. OMNR 1990. Nipigon Landslide Report. Report prepared for the Ont. Min. Nat. Resour. by Trow Ontario Ltd. Regional Engineer's Office, Thunder Bay, Ontario.

220. SAF 1984. Forestry handbook. Second Edition. John Wiley & Sons, Toronto, Ontario. 1335 pp. (Section 12).

221. Duerr, W.A., D.E. Teeguarden, N.B. Christiansen, and S. Guttenberg 1979. Forest resources management. W.B. Saunders Co., Toronto. 612 pp. (Chapters 18 and 21).

222. Armson, K.A. 1977. Forest soils: properties and processes. University of Toronto Press.

ification and road building can increase erosion and sedimentation. Conversion to hardwoods can increase water yield. Converting the forests of a watershed from the natural older growing stands to an intensively managed forest will probably increase the water temperature of streams.²²³ Other detrimental effects of the increase in water yield are increases in water temperature, decrease in water quality, and loss of nutrients.

Larger clearcuts compared to smaller cuts for natural regeneration in the same water basin will produce a higher increment of detrimental effects because of the increase in water yield and the concomitant increase in associated detrimental effects. The magnitude and duration of the effects are not well documented. Nicolson²²⁴ found that for shallow upland black spruce sites, the water yield from harvested areas (including clear, strip, and block cuts) were greater than those from uncut areas for all seven years of the study. The time for the water yield to return to pre-cut levels can be longer than 13 years²²⁵ and up to 35-50 years for spruce, fir, and lodgepole pine.²²⁶

Natural regeneration and the smaller cut area associated with it should produce smaller increases in water yield, reduce

Toronto, Ontario.390 pp. (See p. 261).

223. **USDA 1985.** Management of wildlife and fish habitats in forests of western Oregon and Washington. Forest Service, Pacific Northwest Region, 2 parts of 332 pp. and 302 pp. (p. 221).

224. **Nicolson, J. A. 1988.** Alternate strip clearcutting in upland black spruce V. The impact of harvesting on the quality of water flowing from small basins in shallow -soil boreal ecosystems. *For. Chron.* 64:1. pp. 52 -58.

225. **Armson, K.A. 1977.** Forest soils: properties and processes. University of Toronto Press. Toronto, Ontario.390 pp. (See p. 260).

226. **Golding, D.L. 1974.** Land management practices that affect water yield.p. 13-32. *in* Managing Forest Lands for Water: Proceedings of Research-Management Seminar Held at Edmonton, Alberta, January 1970. Canadian Forestry Service, Dept. of the Environ.,Northern Forest Research Centre, Edmonton, Alberta. 79 pp.

sedimentation, lower nutrient ion concentrations in runoff, and a lower temperature of water runoff as compared to the clearcutting of an area. Standing blocks or strips of timber throughout the cutover would help prevent the loss of nutrients and reduce sedimentation within the forest area before it reaches buffer strips around streams. The nutrients and sediments would be retained within standing timber of the cut area.

3. Wind

Wind can be controlled to a certain extent by the forest, but perhaps, it's a repercussion of the loss of our rural heritage, that the obvious controlling effect of a windbreak²²⁷ is no longer common knowledge. During the hearings, it was surprising that the OMNR did not recognize that the wind can be affected by trees. Although they elaborated on the effects of wind on causing blowdown, they were not aware that the effects of the wind can be mitigated.

Problems caused by wind on forests include:

a). Desiccation of planted trees caused by the wind increasing the evaporation and moisture loss from the seedling can cause death.²²⁸

b). Blowdown of plantation trees because of root deformation has been noted for bare root stock. Whether this will occur with

227. Baer, N. W. 1989. Shelterbelts and windbreaks in the great plains. *J. For.* April, pp. 32—36.

228. Kimmins, J. P. 1987. *Forest Ecology*. Macmillan Publishing Company, New York. 531 pp. (pp. 220).

container stock remains to be seen, as these types of plantations are not old or tall enough to know if their roots will develop deformed.

c). Young plantation trees can be rocked by the wind to the extent that their roots are damaged and the seedling is damaged.

d). Small patches of timber left for wildlife, lakes and streams can often blow down.

e). Wind can blow down stands of mature timber.

f). Leeward cut boundaries are more susceptible to windthrow than windward edges as reported by the SAF,²²⁹ while Kimmins²³⁰ maintains the windward side is most affected.

g). Wind can cause a loss of nutrients after a burn.²³¹

Little can be done to control the effects of a strong wind over a mature forest. Such winds are unpredictable and can blowdown mature stands and leave adjacent stands of strip cut timber standing.²³² Some control over the possible damage to wind along cut edges can be implemented. Two basic concepts apply:

229. **SAF 1984.** Forestry handbook. Second Edition. John Wiley & Sons, Toronto, Ontario. 1335 pp. (Section 3).

230. **Kimmins, J. P. 1987.** Forest Ecology. Macmillan Publishing Company, New York. 531 pp. pp. 218).

231. **Smith, D. H. 1968.** Surface fires in northern Ontario. pp. 41-54. in *Proceedings Annual Tall Timbers Fire Ecology Conference*, March 14-15, 1968.

232. Personal observation 1970. Northern Management Unit, Sankey Reference Area, Kapuskasing District.

a). The shape of the clearcut area can either funnel or dissipate the wind. If the cut becomes narrower in the direction the wind is flowing, the chances of having blowdown are increased as the wind speeds up at the narrow end of the cut.²³³ Conversely, if the cut widens in the direction of wind flow, the chances of damage are lessened as the wind loses speed and causes less damage.

b). Wind velocity within the clearcut area is related to the size of the clearcut and the height of the surrounding trees. As the size of the clearcut increases, the velocity of the wind in the opening increases.^{234,235} Moreover, cut shapes that have a side ratio of 4:1 have lower wind velocities in the clearing than areas with a side ratio of 1:1. A square has a side ratio of 1:1, while a rectangle with two sides four times longer than the other two sides would have a 4:1 side ratio.

These two concepts cannot be solved entirely by either large clearcuts or smaller cuts for natural regeneration. Large clearcuts will increase the desiccation of seedlings as a result of the higher wind velocities, transpiration, and blowdown along the edges of the cut. One of Grossnickle's²³⁶ recommendations for minimizing seedling water stress is:

“Modifying the site: a) Modifying above ground environmental conditions by means of alternative

- 233. **Kimmins, J. P. 1987.** *Forest Ecology*. Macmillan Publishing Company, New York. 531 pp. (pp. 219).
- 234. **SAF 1984.** *Forestry handbook*. Second Edition. John Wiley & Sons, Toronto, Ontario. 1335 pp. (Section 3, p. 127 Figure 24).
- 235. **Baer, N. W. 1989.** Shelterbelts and windbreaks in the great plains. *J. For.* April. pp. 32—36.
- 236. **Grossnickle, S. C. 1988.** Conifer seedling establishment on boreal forest reforestation sites: environmental influences and ecophysical responses. pp. 71—78. *in* Taking Stock: The role of Nursery Practice in Forest Renewal. Proceedings of a symposium. Great Lakes Forest Centre, Sault Ste. Marie, Ont. COFRC Sym. Proc. O-P-16.123 pp.

harvesting practices (i.e., shelterwood)".

Smaller cuts for natural regeneration will have more blowdown because of the increase in edge, but will offer better protection for seedlings from desiccation. Modified cuts for natural regeneration may be more rectangular, as opposed to square in shape, to lessen the effects of blowdown. Losses to blowdown in modified cuts need to be quantified in a more scientific manner to determine how serious they are. Comparisons between several areas of both modified cuts and clear cuts would need to be made to account for the vagaries of the wind.

Wind can also cause erosion. The value of windbreaks of trees for preventing erosion of agricultural land is known, but the extent of the damage caused by erosion on large clearcuts is not quantified. It would appear that from the nature of the wind velocities in large clearcuts that more wind erosion would be expected than in smaller cuts.

4. Species Diversity

A basic quality of the natural forest is its diversity, both within a stand, and between stands. An FRI map shows the variety of tree species that may be found in a natural stand.²³⁷ Within a stand, a variety of lower vegetation and shrubs may be found. The number and type of species will vary from stand to stand and also within a stand. This is aptly illustrated in the Forest Ecosystem

237. For example the FRI map of Delhi township of Temagami District.

Classification Systems of the OMNR.^{238,239} These booklets illustrate the various categories that have been formed by classifying areas of average similar vegetation, tree and soil types. Variation can be expected within each category. Larsen²⁴⁰ stated:

“In the boreal vegetation, as in many other vegetational zones throughout the world, it is difficult if not impossible to establish, on the basis of a given definition of a community, at what point regionally the community ends and another takes it place.”

Fire has somewhat the same effect on the flora and vegetation of an area as for the trees. The establishment of flora will depend upon the availability of the seed and the ease with which that seed is disseminated.²⁴¹ The presence of non-burnt areas within a burn ensures that even species with a short dissemination range may help re-vegetate the area.²⁴² On the other hand, large clearcuts would favour regeneration of those species that can easily disseminate their seed.

The species of flora and fauna that inhabit a stand may vary throughout the life of the stand. In a natural forest, with its mosaic of age classes, the variety of species may be found in stands of different successional stages of development. As a fire only destroys some of the stands, flora and vegetation common to

238. Sims, R. A., W. D. Towill, K. A. Baldwin, and G. M. Wickware. 1990. Forest ecosystem classification for northwestern Ontario. Ont. Min. Nat. Resour., Thunder Bay, Ontario. 191 pp.

239. Jones, R. K., G. Pierpoint, G. M. Jeglum, J. K. Arnup, and J. M. Bowles. 1989. Field guide to forest ecosystem classification for the Clay Belt, Site Region 3e. Ont. Min. Nat. Resour., Toronto, Ontario. 122 pp. + references and notes. (Exhibit 330).

240. Larsen, J. A. 1980. The boreal ecosystem. Academic Press, Toronto. 500 pp. See page 337—338.

241. Larsen, J. A. 1980. The boreal ecosystem. Academic Press, Toronto. 500 pp. See page 329.

242. Larsen, J. A. 1980. The boreal ecosystem. Academic Press, Toronto. 500 pp. (p. 112).

the successional stages of the forest stands will be available to re-inhabit the new forest as it develops.²⁴³

Below the ground, there are a variety of organisms, one of the most important being ectomycorrhiza.²⁴⁴ They provide increased nutrient uptake, water uptake, resistance to drought, resistance to pathogens, resistance to toxins, and impart to the root the ability to survive environmental extremes.²⁴⁵ The types of mycorrhiza change during the year, and throughout the life of the tree. Over 2000 fungal varieties are associated with Douglas-fir.²⁴⁶

When an area is clearcut, the amount of mycorrhiza and other beneficial soil organisms decline. The variety and number of other plant species will change.²⁴⁷ Artificial regeneration and scarification attempt to create conditions that are favourable for spaced young seedling stage of succession of the forest. If the treatment is too harsh an earlier stage of successional development may be obtained and an earlier successional species, such as grass, will occupy the site. In either case, other species will

243. **Farmer, R. E., P. Knowles, and W. H. Parker.** 1982. Genetic resources of the North American boreal forest. pp. 40—51. in *Resources and Dynamics of the Boreal Zone*. Proceedings of a Conference, Thunder Bay, Ontario. 544 pp.

244. **Amaranthus, M.** 1990. Rethinking the ecology and management of temperate forests: the living soil. *Forest Planning Canada*. 6:3. pp. 16—17.

245. **SAF** 1984. *Forestry handbook*. Second Edition. John Wiley & Sons. Toronto, Ontario. 1335 pp. (Section 2).

246. **Amaranthus, M.** 1990. Rethinking the ecology and management of temperate forests: the living soil. *Forest Planning Canada*. 6:3. pp. 16—17.

247. **Kimmins, J. P.** 1987. *Forest Ecology*. Macmillan Publishing Company, New York. 531 pp.

occupy the site, depending upon their ability to seed the area and survive. Release treatments may eliminate or reduce both competitive and non-competitive species. Eventually a mature forest is expected to develop, but one cannot expect the artificially regenerated stands to have the same diversity throughout their life as a natural stand.

If the objective of the OMNR is to develop stands similar to the plantations of the Thunder Bay Tree Nursery Spacing Trials,²⁴⁸ stands will develop with little diversity. It has been observed that the:

“total number of species found under ‘managed’ stands was approximately 22 percent of the total number of understory taxa reported for unmanaged boreal natural stands”.²⁴⁹

On the other hand, some silvicultural techniques can increase the diversity of a stand.²⁵⁰ It has not been clearly established as to how pure species composition of the plantations is to be. The OMNR has contended that plantations will not be purely one species as other species will invade the site.²⁵¹ The OFIA/OLMA has illustrated that their plantations planted at the correct spacing, will

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248. **OFIA/OLMA 1990.** Panel 8 Renewal. Environmental Assessment Hearings, Toronto, Ontario. 159 pp + appendices. (appendix B).
249. **Towill, W. D. 1987.** Biomass production, structure and dynamics of four white spruce (*Picea glauca* (Moench) Voss) plantations in North Central Ontario. M.Sc. Thesis, School of Forestry, Lakehead University, Thunder Bay, Ontario. 220 pp.
250. **Hunter, M.L. 1990.** Wildlife, forests and forestry. Principles of managing forests for biological diversity. Prentice Hall, Englewood Cliffs, N.J. 370 pp. (See pp. 200—234).
251. **OMNR 1974.** Survival and growth of tree plantations on Crown lands in Ontario. Ont Min. Nat. Resour., Division of Forests, Toronto, Ontario. 17 pp. (pages include sub-pages), (Exhibit 169) and **OMNR 1989.** Survey of artificial regeneration in northern Ontario, Statement of Evidence Panel IV, Environmental Assessment Hearings, Thunder Bay, Ontario. 278 pp. (pp. 221—248).

develop into pure plantations even without herbicide treatment.²⁵² If the intent of managing a plantation is to increase the growing space occupied by the desired trees at the time of the planting, it can only be accomplished at the expense of decreased diversity of life forms.²⁵³ Hansen²⁵⁴ reported that he could not find:

“rigorous studies comparing the in-stand characteristics of intensively managed plantations with natural forests of similar age”.

The introduction of exotic plantations species, such as Norway spruce, may have a dramatic effect on reducing the diversity of life forms of an area.²⁵⁵

In addition to the diversity of species, there is genetic variation within a species. The exasperating component of species genetic diversity is that:

“with the exception of jack pine, we have only sketchy information on the genetic features of populations.”

and:

“The genetics of numerous ecologically important boreal shrubs and herbs is even less well known.”²⁵⁶

252. OFIA/OLMA 1990. Panel 8 Renewal. Environmental Assessment Hearings, Toronto, Ontario. 159 pp + appendices. (appendix B).

253. Hansen, A. J. 1990. Lessons from natural forests. Forest Planning Canada. 6:3. p. 18.

254. Hansen, A. J. 1990. Lessons from natural forests. Forest Planning Canada. 6:3. p. 18.

255. Hunter, M.L. 1990. Wildlife, forests and forestry. Principles of managing forests for biological diversity. Prentice Hall, Englewood Cliffs, N.J. 370 pp. (See pp. 38—40).

256. Farmer, R. E., P. Knowles, and W. H. Parker. 1982. Genetic resources of the North American boreal forest. pp. 40—51. in Resources and Dynamics of the Boreal Zone. Proceedings of a Conference, Thunder Bay, Ontario.

Intensive silvicultural programs using collected seed or genetically improved seed reduce the amount of genetic variation within a species.²⁵⁷ In areas where poorer trees are left to regenerate the forest there may a decrease in the genetic potential of the future trees. To ameliorate the problem of retaining genetic diversity in the boreal forest Farmer *et al.*²⁵⁸ recommended:

“Natural regeneration in the boreal forest should be used whenever possible to ensure continuation of local populations, planting should be considered as a tool for rectifying silvicultural failure, for obtaining regeneration in inherently difficult situations, and for changing species composition. Planting stock should have as broad a genetic base as the natural stand it replaces.”

“Tree improvement programs should include a large component of fundamental genetics research designed to more completely characterize patterns of natural variation. In the long run, we must have a better understanding of the boreal species before either improvement can be made or adequate gene conservation programs instituted. In particular, we need more data on the degree to which silviculture and breeding are changing the nature of genetic variation.”

Other parts of the world have recognized the benefits of natural regeneration:

“Natural regeneration is the ideal form of stand renewal. Stands renewed in this way are characterized by a stability and continuity of productivity, resulting from the influence of all components of the complex forest ecosystem (habitat and biocoenosis).²⁵⁹

- 257. Farmer, R. E., P. Knowles, and W. H. Parker. 1982. Genetic resources of the North American boreal forest. pp. 40—51. in *Resources and Dynamics of the Boreal Zone. Proceedings of a Conference, Thunder Bay, Ontario.* 544 pp.
- 258. Farmer, R. E., P. Knowles, and W. H. Parker. 1982. Genetic resources of the North American boreal forest. pp. 40—51. in *Resources and Dynamics of the Boreal Zone. Proceedings of a Conference, Thunder Bay, Ontario.* 544 pp.
- 259. Yugoslavia 1986. *The forestry of Yugoslavia.* XVIII IUFRO World Congress, Ljubljana. 258 pp. (p. 179).

Smaller cuts and natural regeneration methods have been recommended for Nova Scotia.²⁶⁰

In Newfoundland and Labrador it was noted that:

"The transformation of the species-rich natural forest to single species stands will result in significant alteration of the forest ecosystem, have a potential to adversely affect water quality, fish and wildlife, and will require considerable commitment of funds. The environmental consequences of large scale tree removal (clearcutting) and intensive management practices are poorly understood, and largely undocumented for site conditions in Newfoundland. However, given the often poor site conditions, i.e. shallow soil, acidic podzol soils, boggy wetland areas or steep slopes, the potential for environmental damage is large. Studies elsewhere, where site conditions are generally more favourable, are expected to underestimate impacts in Newfoundland".²⁶¹

Two important factors of silviculture have not been recognized in Ontario:

a). "The tools and practices of silviculture can be used to produce whatever vegetation patterns or goods and services are deemed appropriate by the forest owner."²⁶²

b). "Even where intensive silviculture does produce very simple stands or monocultures, these can be integrated into whole landscapes as valid components of

260. **Johnson, R. S. 1986.** Forests of Nova Scotia, Dept. Lands and Forests, Halifax, Nova Scotia. 407 pp. (pp. 355—357).

261. **Ernst, W., H. Hall, S. Hall, R. Matheson, J. Osborne, and R. Wilson. 1981.** A review of environmental impacts associated with particular forestry practices in eastern Canada. A brief presented to Newfoundland and Labrador Royal Commission on forest protection and management. Environmental Protection Service, Atlantic region. Report EPS 7-AR-81-1. 101 pp. (p. 73).

262. **Hunter, M.L. 1990.** Wildlife, forests and forestry. Principles of managing forests for biological diversity. Prentice Hall, Englewood Cliffs, N.J. 370 pp. (See pp. 201.)

overall landscape diversity.”²⁶³

The various silvicultural ground rules for normal operations and for areas of concern are vague with respect to the measurement of success, *i.e.* 40 to 100% stocking to desired species.²⁶⁴ This offers a tremendous leeway as to the type of stand that may be expected to develop in the future. The standards give no indication that diversity will be increased or decreased. In contrast, the USDA Forest Service is subject to the National Forest Management Act (NFMA) that includes three provisions for maintaining and improving diversity:²⁶⁵

a). “NFMA requires the Forest Service to maintain viable populations of existing native and desirable non-native vertebrate species.

b). NFMA directs the Forest Service to maintain the diversity of tree species present at the onset of the management plan to protect the resources and habitats upon which vertebrate populations and endangered species depend.”

c). NFMA directs the Forest Service to preserve and enhance the diversity of plant and animal communities and tree species within each management area so that the diversity is equal to or greater than that of a natural, unmanaged forest.”

Ontario has neither the legislation or the management procedures to ensure that the biological diversity of an area is maintained or

263. Hunter, M.L. 1990. Wildlife, forests and forestry. Principles of managing forests for biological diversity. Prentice Hall, Englewood Cliffs, N.J. 370 pp. (See pp. 201.

264. OMNR 1989. Panel XV, Reference No. 3A. Red Lake Crown Management Unit Timber management Plan. 145 pp. (see pp. 53–81).

265. Hunter, M.L. 1990. Wildlife, forests and forestry. Principles of managing forests for biological diversity. Prentice Hall, Englewood Cliffs, N.J. 370 pp. (See pp. 292–293.

improved.

5. Wildlife

The featured species management recently designed by the OMNR²⁶⁶ is a step in the direction to maintain habitat requirements of most of the species of Ontario, but it does have some serious deficiencies.

First, it assumes that the location of all species are known and may therefore be planned for. Without knowing the location of the various wildlife species at the present time, their location must be indicated on 'an identify as you plan and cut'.

Second, knowledge of habitat requirements for, area sensitive species are lacking for Ontario, and as the authors point out, assumptions are necessary. Information on habitat requirements is a prerequisite if wildlife is to be provided for. Information that is available is sparse in nature and such information that exists has not been gathered into a format that a manager may readily use. The various resource manuals of the OMNR provide assistance in suggesting management techniques for some species, but there is still the problem of trying to apply these techniques to an area that lacks important site information. In comparison, the USDA has assembled pertinent wildlife information to assist forest resource managers.^{267,268} Without having such information available in On-

266. **Baker, J. and D. Euler.** 1989. Ont. Min. Nat. Resour., Toronto, Ontario. 19 pp. + tables. Exhibit 433).

267. **USDA** 1985. Management of wildlife and fish habitats in forests of western Oregon and Washington. Forest Service, Pacific Northwest Region, 2 parts of 332 pp. and 302 pp. p. 221.

268. **USDA** 1979. Wildlife habitats in managed forests the Blue Mountains of Oregon and

tario, there is no assurance that both specific wildlife inhabiting an area and specific wildlife habitat can be identified in the field prior to be harvested.

Third, it is assumed that the:

“moose or deer guidelines are applied across each forest management unit”.

Whether this happens remains to be seen. A larger question concerns the validity of trying to increase the moose herds. It has been contended that caribou were more abundant than moose prior to 1900.²⁶⁹ Caribou herds in the boreal forest only occur in a few areas now. The cause(s) for the loss of the caribou are not clear, but may be related to changes in habitat and hunting pressures. Reliance on the moose guidelines for all management units offers no assurance that habitat for the once more indigenous species, caribou, and other species will be provided for. The question remains as to why manage to increase moose that were not the predominant species in the past.

Fourth, the element of time in the planning of the featured species management is missing in the Ontario model. There are two factors that the lack of consideration of time affects. Provision of habitat is limited to the **area** and **time** period of the five-year plan. The provision of moose corridors in a cutover may be suitable for moose for a period of time until the cutover regenerates and the

Washington. Forest Service, Washington, D.C. Air. Handbook No. 553. 512 pp.

269. Peterson, R.L. 1955. North American moose. University of Toronto Press, Toronto, Ontario. 280 pp. (See pp. 45—54).

canopy closes to reduce the use of the cutover for feeding. If intensive management of the industry and OMNR successfully produces plantations with closed canopies, the cutover area will lose its ability to support the moose. Can one can easily visualize the migration of moose occurring every five years as an area loses its capacity to support them? In addition, the factor of time is critical for areas that are identified as mature to old growth stages for providing habitat for the 19 species in the Boreal forest and for the 19 species in the Great-Lakes St. Lawrence forest region²⁷⁰, assuming that such areas would be identified. What happens to these areas in the future as they become older? Whether or not fire is excluded from them, they will change and lose the characteristics of mature to old growth and the habitat for species dependent on these types of forests will be gone unless it is planned for. In a management area that harvests stands as they reach maturity, provision of mature to old growth habitat must be planned. This would require long term planning for the whole of a management unit to ensure that forest are allowed to develop to form a continuity of developing mature to old growth.

Fifth, the retention of relatively small strips of timber along streams, around lakes, and for moose corridors will be prone to blowdown in large clearcuts. As mentioned in the section on wind, the larger the clearcut, the greater the probability of wind damage to residual trees. The value of such corridors remains to be quantified, but they are better than no corridors.²⁷¹ Although the corri-

270. **Baker, J. and D. Euler.** 1989. Ont. Min. Nat. Resour., Toronto, Ontario. 19 pp. + tables. Exhibit 433).

271. **Hunter, M.L.** 1990. Wildlife, forests and forestry. Principles of managing forests for biological diversity. Prentice Hall, Englewood Cliffs, N.J. 370 pp. (See pp. 129—130).

dors probably are useful to some species it would be beneficial to have them planned for more than moose only.

Sixth, the concept of increasing edge effect for wildlife is missing. This relates to the fourth point above. Edge effect can increase the diversity of plants by manipulating the species composition, and age-classes.²⁷² An edge is:

“the place where plant communities meet or where successional stages of vegetative stand conditions within plant communities come together.”²⁷³

Within a management unit, the different number of distinct edges that could be created depends upon the number of plant communities and the number of age-classes. The degree of contrast, i.e. difference in age-classes, increases the diversity and species richness.²⁷⁴ For a given area, the amount of diversity can theoretically be increased with smaller patches dispersed throughout the area, rather than one large patch equal in size to the sum of the smaller ones. However, the number of wildlife species may increase and then decrease as the patch size increases.²⁷⁵ The ideal size for Ontario is not known, but Euler²⁷⁶ recommended cuts of 80 to 130 ha for the purposes of wildlife considerably smaller in size

272. Euler, D. n.d. Vegetation management for wildlife in Ontario. Ont. Min. Nat. Resour., Toronto, Ontario. 62 pp.

273. USDA 1985. Management of wildlife and fish habitats in forests of western Oregon and Washington. Forest Service, Pacific Northwest Region, 2 parts of 332 pp. and 302 pp. (p. 117).

274. USDA 1985. Management of wildlife and fish habitats in forests of western Oregon and Washington. Forest Service, Pacific Northwest Region, 2 parts of 332 pp. and 302 pp. (p. 121).

275. USDA 1985. Management of wildlife and fish habitats in forests of western Oregon and Washington. Forest Service, Pacific Northwest Region, 2 parts of 332 pp. and 302 pp. (p. 122).

276. Euler, D. n.d. Vegetation management for wildlife in Ontario. Ont. Min. Nat. Resour., Toronto, Ontario. 62 pp.

than the 4000 ha viewed as a large clearcut by Oldford.²⁷⁷ In addition, the shape of the clear cut area can increase the amount of edge and the subsequent edge effect.²⁷⁸

Planning for wildlife requires planning over the whole of the management unit to achieve the continuity of edge effects and age-classes beneficial to wildlife. Allowable cut allocated amounts and location would need to be adjusted to achieve this continuity effect.

Modified management techniques employing smaller cuts combined with limited harvesting of larger areas to meet the requirements of area dependent species can meet the needs of wildlife. Initially, strip cutting may not produce the best size of clearcut for increasing wildlife, but after an area has been completely cut an area composed of one or two age-classes will develop. Interspersed with areas of uncut timber, the cut areas would form a mosaic of vegetation favourable for wildlife.

6. Site Conditions

Management of Ontario's forest is not site specific. The OMNR contends that:

"The Silvicultural Ground Rules describe those optional methods as a range of acceptable silvicultural practices which can be employed in the management of similar site conditions within each working group/forest unit, and represent "normal" management practice for the

277. **Environmental Assessment Hearings 1989.** Transcripts for Panel X. Thunder Bay, Ont. pp. 14480-14485.

278. **Hunter, M.L. 1990.** Wildlife, forests and forestry. Principles of managing forests for biological diversity. Prentice Hall, Englewood Cliffs, N.J. 370 pp. (See p. 108).

management unit.”²⁷⁹

If harvesting and silviculture were conducted to consider “similar site conditions”, more variety in the type and size of cuts would be expected to occur in the province. The critical points are, what are similar site conditions and what is their size. As Spurr²⁸⁰ noted:

“In nature one observes all degrees of change between communities—from abrupt to imperceptible.”

He also notes:

“The forest community, then, cannot be precisely defined. It varies in composition and structure.”²⁸¹

Larsen²⁸² noted:

“The habitat of individual plants is a more narrowly circumscribed set of conditions than can be defined in such broad terms and, in truth, every meadow, forest, muskeg—every community is an aggregation of many habitats occupied by plants of many different species.”

The variety that may be found on a small area is indicated in the forest ecosystem classifications of the OMNR. Forest ecosystems are classified on the basis of soil and vegetation types and provide a “*modal*” description for areas as small as 10 ha.²⁸³ Use

279. OMNR 1987. Class environmental assessment for timber management on Crown lands in Ontario. Ont. Min. Nat. Resour., Toronto, Ont. 202 pp. + appendices. (Exhibit 47).

280. Spurr, S. H. and B. V. Barnes. 1973. Forest Ecology. The Ronald Press Company, New York. 571 pp. (p. 386).

281. Spurr, S. H. and B. V. Barnes. 1973. Forest Ecology. The Ronald Press Company, New York. 571 pp. (p. 383).

282. Larsen, J. A. 1980. The boreal ecosystem. Academic Press, Toronto. 500 pp. (See page 307).

283. Sims, R. A., W. D. Towill, K. A. Baldwin, and G. M. Wickware. 1990. Forest ecosystem

of the term “*modal*”, or the value of the variables that occur most frequently, is an indication of the variability that can occur in these small areas. In fact small distinct, or small vegetational changes may occur within an area of 10 ha. Thus, the large variety of site conditions that can occur in a small area makes it impossible to apply site specific operations unless they were on an a much smaller scale than practiced now. Both silviculture and harvest operations are normally much larger than 10 ha. Industry did not specify a minimum size of harvest operations.²⁸⁴

For the province, the topography for the area of the undertaking varies from moderately; to strongly broken to weakly broken, with the majority of the area being moderately to weakly broken.^{285,286} Soil material ranges from deep loams and clays to shallow sandy soils, with the majority being shallow sandy soils over precambrian bedrock with locally deep deposits of sand.²⁸⁷ A finer division of sites is indicated by the Ontario Land Inventory Land Classification maps that indicate the topography, soil depth and texture.²⁸⁸ Large areas of shallow soils, and sandy soils are indicated by these maps, but the features indicated are the most common of the area. Smaller areas of different features may be found within these larger areas. Finally, there are the forest ecosystem classifications that may be used for areas down to 10 ha in size.

classification for northwestern Ontario. Ont. Min. Nat. Resour., Thunder Bay, Ontario. 191 pp. (p. 1).

284. **OFIA/OLMA 1990.** Panel 8 Interrogatories (Renewal of the Timber Resource) responses to Forests For Tomorrow, Question #7. Environmental Assessment Hearings, Toronto, Ontario. 1 p.

285. **Department Lands and Forests. 1963.** Ontario resources atlas. Dept. of Lands and Forests. Toronto, Ontario. 33 pp. (p. 3).

286. **OMNR 1988.** Surficial geology of Ontario. map.

287. **Department Lands and Forests. 1963.** Ontario resources atlas. Dept. of Lands and Forests. Toronto, Ontario. 33 pp. (p. 2).

288. **OMNR n.d.** Ontario Land Inventory Land Classification maps, Ont. Min. Nat. Resour., Surveys mapping and remote Sensing Branch, North York, Ontario. Maps.

At present the OMNR silvicultural and harvesting operations appear to be operating at a scale between the Ontario Land Inventory maps and the forest ecosystem classification.

7. Site Damage

The forest sites of Ontario are fragile with respect to forest harvesting and silviculture operations for four main reasons; the depth of the soil, topography, and wet soil and organic areas. Soil depth over most of the area of the undertaking is shallow²⁸⁹ on terrain that is not level. Operations that remove all or part of this layer of soil reduces the productivity of the site. It is known that harvesting and silvicultural operations can have harmful effects on the site, but the magnitude of this effect is not well documented for Ontario. There is no quantitative estimate of the degradation similar to the estimate made in British Columbia.²⁹⁰ This report estimated the damage to timber productivity caused by various harvest and silviculture operations. The loss of timber productivity was related to the provincial loss in stumpage. Ground skidding was determined to cause the most harvest damage, while windrowing and blase scarification caused the most damage for silviculture operations. Damage was estimated to occur on 20% of the area at a potential loss of \$80 million annually to the province. Instead of using hard data for specific areas in Ontario, reliance must be placed on information from other areas.

289. **Department Lands and Forests. 1963.** Ontario resources atlas. Dept. of Lands and Forests. Toronto, Ontario.33 pp. (p. 3).

290. **Utzig G. P. and M. E. Walmsley. 1988.** Evaluation of soil degradation as a factor affecting soil productivity in British Columbia A problem analysis Phase I. Issued under Forest Resources Development Agreement, Can, forest Serv., Pacific & Yukon Regions, Victoria, B.C. 111 pp. + appendices.

Harvesting operations can have a detrimental effect by compacting and rutting soil and rutting in organic areas. Although steps have been taken by the industry to use low pressure tires and winter harvesting of wet areas, both compaction and rutting are common in logging areas. The damage associated with such activity would be applicable to Ontario. Scandinavian countries have developed lighter logging machinery that produces less site damage and leave the branches and tops of the trees on the site.

Scarification, particular with heavy scarification equipment that is in common use in Ontario^{291,292} can have a devastating effect on the site. One effect can be the removal of the soil and/or topsoil. Removing the soil indubitably reduces the productivity of the site, and removal of the topsoil removes the best material of the site.^{293,294} In some cases, scarification is both an unnecessary and uneconomical treatment.²⁹⁵

Mechanical site preparation can form channels that can cause increased erosion. In the United States, site preparation has been noted as the major cause of erosion.^{296,297} Road building landings.

291. **OMNR n.d.** Silvicultural equipment reference catalogue for northern Ontario. Ont. Min. Nat. Resour., separate paginated sections.
292. **Thrower, J. S. 1984.** Scalping of surface soil adversely affects the growth of white spruce planted on a lacustrine soil near Thunder Bay, Ontario. Undergraduate thesis, School of forestry, Lakehead University, Thunder Bay, Ontario. 48 pp.
293. **Mitchell, N. J. 1985.** The affects of soil disturbance on the growth of white spruce planted on sandy soils in the Thunder Bay area. Undergraduate thesis, School of forestry, Lakehead University, Thunder Bay, Ontario. 37 pp.
294. **Foster, N. W. and I. K. Morrison. 1988.** Effects of site preparation and full tree logging on nutrient cycling. pp 28-46. *in* Aspects of site preparation biology and practice. P. M. Corbett. Proc. Workshop held 27-28 Sep 1988, Fort Frances, Ont., Ont. Min. Nat. Resour., Northwestern Ont. For. technological Development Unit, Thunder Bay, Ont.
295. **Sianga, C.W. 1986.** Establishment and early growth of Jack pine in Acton township, Ontario. MScF thesis, School of Forestry, Lakehead University, Thunder Bay, Ont. 63 p.
296. **Blosser, R. O. 1979.** A review of current knowledge and research on the impact of alternative

and skid trail all contribute to erosion. Compaction caused by landings and short-term access roads can cause a loss of productivity.²⁹⁸

The use of herbicides may be detrimental to the site. Ernst *et al.* noted:

"Natural regeneration after a clear-cut often consists of pioneer hardwoods and other commercially undesirable species. These species are ecologically important in promoting recovery after logging disturbances as they regenerate quickly, providing immediate ground cover and protection against erosion. Hardwoods, because of their annual leaf litter production and deeper root systems, are also better able to restore nutrients lost during the harvesting (Goldsmith, 1980). The increasing use of conifer release agents may therefore be ecologically unsound (Wall, 1975). The resulting shift in the structure and composition of the plant community is also of concern because of concurrent shifts in the populations of some animals (N.R.C., 1978)."²⁹⁹

In addition, the reduction of hardwoods on a site by herbicides will contribute to the loss of nutrients by reducing the plant cover on a recently cut area.

Dead wood in the forest can play an important part in providing nutrients and organic matter to the forest floor. Full-tree harvest-

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- forest management practices on receiving water quality. Stream Improvement Bulletin No. 322.
297. **SAF 1984.** Forestry handbook, Second Edition. John Wiley & Sons, Toronto, Ontario. 1335 pp. (See p671).
298. **Ernst, W., H. Hall, S. Hall, R. Matheson, J. Osborne, and R. Wilson. 1981.** A review of environmental impacts associated with particular forestry practices in eastern Canada. A brief presented to Newfoundland and Labrador Royal Commission on forest protection and management. Environmental Protection Service, Atlantic region. Report EPS 7-AR-81-1. 101 pp.
299. **Ernst, W., H. Hall, S. Hall, R. Matheson, J. Osborne, and R. Wilson. 1981.** A review of environmental impacts associated with particular forestry practices in eastern Canada. A brief presented to Newfoundland and Labrador Royal Commission on forest protection and management. Environmental Protection Service, Atlantic region. Report EPS 7-AR-81-1. 101 pp.

ing removes the finer branches with their needles or leaves, which contain the majority of the nutrients. Larger dead material on the forest floor can provide habitat for animals and organisms.³⁰⁰⁻³⁰² Removal or piling of this material through harvesting and silvicultural process can affect the natural sequence of decomposition and habitats for wildlife and organisms.

Ernst *et al.*³⁰³ noted that clearcutting can increase peak stream flow, reduce minimum flow during the dry season, leach nutrients and elements from the soil and deposit them in the streams, cause acid runoff, enhance erosion and siltation of streams, degrade water quality if no buffers are included around water bodies. Moreover, they noted that the size of clearcuts is important:

“in determining the magnitude of these effects.”

and recommended that:

“forest harvesting guidelines should limit the size of clearcuts and the time interval between adjacent cuts.”

Ontario is not bereft of large clearcuts, thus one can expect a larger magnitude of these effects (see Part II).

300. Maser, C. 1988. The redesigned forest. R. & E. Miles, San Pedro, California. 234 pp. (pp. 96—98).
301. Kimmins, J. P. 1987. Forest Ecology. Macmillan Publishing Company, New York. 531 pp. (p. 93).
302. Hunter, M.L. 1990. Wildlife, forests and forestry. Principles of managing forests for biological diversity. Prentice Hall, Englewood Cliffs, N.J. 370 pp. (See pp. 157- 180).
303. Ernst, W., H. Hall, S. Hall, R. Matheson, J. Osborne, and R. Wilson. 1981. A review of environmental impacts associated with particular forestry practices in eastern Canada. A brief presented to Newfoundland and Labrador Royal Commission on forest protection and management. Environmental Protection Service, Atlantic region. Report EPS 7-AR-81-1. 101 pp. (p. 74).

Nutrient losses from the soil of cutovers is not well documented for Ontario, but most studies indicate that the shallow soiled sites may not be able to sustain intensive management or full tree harvesting.³⁰⁴ For example, Foster and Morrison³⁰⁵ indicate that:

"There were sufficient nutrient reserves in the soil to replace the projected nutrient drain associated with another 100-year rotation of spruce if conventional harvesting were conducted."

Rotations proposed for the future may well be below 100 years for spruce; Osborn used rotations of 50, 60, 90, and 120 in his models,³⁰⁶ while industry stated that rotations of 50 to 70 will be used in the future.³⁰⁷ Kimmins³⁰⁸ noted the detrimental effect of shorter rotations on poorer sites and stated that:

"most investigations have concluded that medium to long (80-120 years) rotating harvesting of temperate forests in which only stems are removed poses little threat of site nutrient depletion."

He also pointed out that:

"In younger stands the ratio of sapwood to heartwood is higher than in older stands, as is the ratio of crown biomass to stem biomass. Sapwood generally has higher nutrient concentrations than heartwood; crown materials higher than stems. Shortening rotations reduces the age at harvest and therefore compounds the effects of in-

- 304. **Forests for Tomorrow 1990.** Witness Statement No. 1, Ecological impacts of timber management activities. 34 pp.
- 305. **Foster, N.W. and I.K. Morrison 1987.** distribution and cycling of nutrients in a natural *Pinus banksiana* ecosystem ecology. In *Ecology* 57: 110- 120.
- 306. **OMNR 1989.** Statement of evidence. Panel IV. Environmental Assessment Hearings. Ont. Min. Nat. Resour., Toronto, Ontario.
- 307. **Environmental Assessment Transcripts. 1990.** Transcripts of Panel 7 of the OLLA/OLMA tending and protecting the timber resource. pp. 36936.
- 308. **Kimmins, J.P. 1974.** Sustained yield, timber mining, and the concept of ecological rotation: a British Columbian view. *Forestry Chronicle* 50:1. pp. 27-31.

creasing utilization standards by increasing the proportion of stems that is sapwood, and the proportion of crown material in the harvested biomass."

Thus, short rotations combined with intensive biomass utilization may create problems of reduced soil fertility. Kimmins³⁰⁹ elaborates further on page 481-482, where he points out that

"On a site with very slow replacement and/or poorly developed nutrient accumulation mechanisms, even a small loss may require a substantial period for replacement."

Foster and Morrison (1987) point out that full-tree logging leaves sufficient nutrient reserves and replenishment at this site for early growth. For later growth, it will be as before, if it is assumed that:

"soil nutrient reserves will be protected from leaching and erosion by rapid revegetation."

plus the nutrients in the slash and forest floor horizon should be conserved.

Timmer *et al.*³¹⁰ indicated that:

"shortages of Ca, P, and K will occur on the shallow spruce, hardwood, and balsam fir sites respectively, when harvested by full-tree methods."

309. Kimmins, J.P. 1974. Sustained yield, timber mining, and the concept of ecological rotation: a British Columbian view. *Forestry Chronicle* 50:1. pp. 481-482.

310. Timmer, V.R. H.M. Savinsky and G.T. Marck 1982. Impact of intensive harvesting on nutrient budgets of boreal forest stands. In *Resources and Dynamics of the Boreal Zone*. Thunder Bay, Aug, 1982. edited by R.W. Wein, R.R. Riewe and I.R. Methven. P 131-147. Ottawa. Association of Canadian Universities for Northern Studies.

Gordon³¹¹ observed for full tree logging that:

"What this implies is that if full-tree harvesting can proceed anywhere in the boreal forest, it will be on these mixedwood sites."

He also noted:

"Data for other boreal forest stands such as black spruce indicate that dry outwash sand plains and organic soils may not sustain full-tree logging."

Weetman³¹² stated:

"Site depletion by nutrient exports in harvesting trees does not seem to be of major concern, provided full-tree harvesting is restricted to good sites."

He also noted that a long cycle (50-100 years) is required to balance inputs and exports, and that whole-tree (above ground part of tree) logging was not recommended for poor forest sites with low nutrient reserves.

The question of nutrient depletion depends on the type of site being dealt with. There appears to be problems on shallow soils, organic soils, and possibly outwash sands. The area of the undertaking in Ontario consists of mainly such soils as can be seen on the Ontario Land Inventory maps and the Surficial Geology of

311. **Gordon, A.G. 1981.** Impacts of harvesting on the nutrient cycling in the Boreal mixedwood forest. In *Boreal Mixedwood Symposium*. COJFRC Symposium Proceedings 0-P-9, Canadian Forest Service, Sault Ste. Marie. p 121-140.

312. **Weetman, G.F. 1983.** Forestry practices and stress on Canadian forest land. In *Stress on Land in Canada* by W. Simpson-Lewis, R. McKechnie and V. Neimanis, p. 261-301. Folio No. 6. Ottawa, Environ. Canada, Lands Directorate, Policy Research and Development Branch. 323 pp. (See p. 281).

Ontario.

The foremost studies on nutrient loss and comprehensive effect of clear cutting on erosion water yield and quality are those of Bormann *et al.*³¹³ In a series of studies over a period of years the effect of clear and modified cutting of **controlled experiments and commercial clearcuts** were systematically studied. Their recommendations, although based on work in New England, have had some acceptance by the U.S. Forest Service. These recommendation for clear cutting (Stem-only)³¹⁴ are as follows:³¹⁵

i. Cutting should be limited to sites with strong recuperative capacity. Clear-cutting on steep slopes or on thin soils can lead to long-term changes in the structure, metabolism, and biogeochemistry of the forest ecosystem. This was shown dramatically in the deforestation experiment at Hubbard Brook in which small patches of forest with this soil on bedrock were converted to bare rock by the accelerated erosion that followed cutting (Reiners *et al.* 1979).

ii. Cutting should be done in the context of a larger watershed unit and in relation to all previous cuts in the unit. This will allow the maintenance of water quality by dilution and by "purifying" activities within the drainage system.

iii. Cuts should be relatively small, for example, several hectares, to insure the availability of seed sources and to minimize losses of dissolved substances and eroded material. Two methods of clearcutting—block cutting and progressive strip-cutting—are under study at Hubbard Brook. Block-cutting is a complete clear-cut done all at once. In progressive strip-cutting all trees are har-

313. Bormann, F. H. and G. E. Likens. 1979. Pattern and process in a forested ecosystem. Springer-Verlag, New York. 253 pp.

314. Stem only is equivalent to conventional harvesting methods, where the tops and branches are left on the site.

315. Bormann, F. H. and G. E. Likens. 1979. Pattern and process in a forested ecosystem. Springer-Verlag, New York. 253 pp. (p. 226).

vested over a 4-year period; the forest is divided into a series of 25-m strips, and every third strip is harvested at 2-year intervals. Preliminary data (Hornbeck *et al.* 1975b) indicate that accelerated water and nutrient losses may be significantly reduced by progressive strip-cutting.

iv. The cutting and harvesting procedure should do minimum damage to the forest floor. This will safeguard the natural regenerative capacity of the ecosystem and sustain area-wide control over erosion.

v. Roads should consume an absolute minimum amount of area, commensurate with sound ecological and engineering principles.

vi. Mechanical site damage to the stream channels should be avoided by leaving a sufficiently wide strip of uncut trees along both banks.

vii. Proper ecological weight should be given to species, such as pin cherry, raspberry, and elderberry, which have little importance as a source of wood products. These exploitive species play an important role in the recovery process by conserving nutrients and minimizing erosion and are also important sources of food for wildlife.

viii. Planned rotation times should be long enough for the ecosystem to regain, by natural processes, nutrients and organic matter equivalent both to that lost as a result of product removal and to those losses accelerated by clear-cutting. Current studies in the White Mountain region (Covington, 1976) suggest that, on the average, about 65 years is required for organic matter in the forest floor to rebuild to precutting levels. Hence we suggest that a rotation time in excess of 65 years is compatible with natural regenerative processes. The U.S. Forest Service guidelines for management of timber harvest in the White Mountain National Forest suggest a 110- to 120-year rotation for cutting (Weingart, 1974)."

Full-tree harvesting, the most common procedure in Ontario, combined with the large clearcuts of sites of low productivity would logically be expected to exhibit the same detrimental effects as noted on the more productive sites of Hubbard Brook. Unfortunately, we do not know the magnitude of these detrimental effects over the area of the undertaking, as Ontario has not instituted long-term studies to examine the effect on the long term productivity of the forests. However, we do know that large clearcuts are more detrimental to sites than smaller cuts; that erosion and nutrient losses increase with the size of the area cut and time that vegetation is kept off the site, and that harvesting and scarification damage to the forest floor can increase erosion and nutrient loss. Most important, we know that these detrimental effects to the site can be reduced by using smaller cuts, less severe scarification methods, harvesting equipment that does minimal site damage. Modified cutting favouring natural regeneration is a procedure that could be applied to replace existing methods to reduce detrimental site effects.

8. HOLISTIC PLANNING.

A manager appears to be faced with a plethora of dilemmas in attempting to prepare a plan that considers the needs of the industry, and the ecology of an area. The U.S. Forest Service began implementation of a complex system of managing all the values of the forest in 1974.³¹⁶ At the core of the process was a computerized linear program, FORPLAN, that was to optimize the achievement of specified objectives. Vast amounts of sundry resource information were collected for use in the program;³¹⁷⁻³¹⁹ considerably more information than we have about the forest resources of Ontario. For example, how many species are there in the forests of Ontario? Hunter³²⁰ noted that few studies have been completed, but one of the more extensive studies found 3,682 species in the forests of England, excluding microorganisms. In spruce-fir forests of Maine, six new species of arachnid were recently reported.³²¹ Although the process of using FORPLAN enabled forest managers to become more aware of the of the capabilities and the various demands on the forest, FORPLAN has not met

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316. **Behan, R.W. 1990.** The RPA/NFMA: Solution to a nonexistent problem. *J. of Forestry*. 88:5. pp. 20—25.
317. **USDA 1985.** Management of wildlife and fish habitats in forests of western Oregon and Washington. Forest Service, Pacific Northwest Region, 2 parts of 332 pp. and 302 pp. (p. 117).
318. **USDA Forest Service 1985.** Draft proposed land and resource management plan. Superior National Forest. U.S. Forest Service, Duluth, Minn. 5 separately paginated chapters + appendices.
319. **USDA Forest Service 1985.** Draft proposed land and resource management plan. Huron-Manistee National Forest. U.S. Forest Service, 421 South Cadillac. MI. 5 separately paginated chapters + appendices.
320. **Hunter, M.L. 1990.** Wildlife, forests, and forestry. Principles of managing forest for biological diversity. Prentice Hall, Englewood Cliffs, N.J. 370 pp. (See p. 9).
321. **Hunter, M.L. 1990.** Wildlife, forests, and forestry. Principles of managing forest for biological diversity. Prentice Hall, Englewood Cliffs, N.J. 370 pp. (See p. 9).

up to everyone's expectations. Barber *et al.*³²² described it:

"Unfortunately, this toy was a transformer, a deceiver. In one form, it was a useful tool, providing the Forest Service with much-needed insight into its planning issues and the national forest's production capacities; yet it was also a mask, hiding the decision-making process from the public and sometimes from the Forest Service itself."

In addition, the complete planning process has been severely criticized:

"I believe that the process is depersonalized, bureaucratized, centralized, "legalized" and it may well be paralyzed."³²³

However, the problems with the management process experienced by the U.S. Forest Service are a consequence of the implementation of multiple use planning. Barber and Rodman³²⁴ in their criticism of FORPLAN, also noted:

"...it's also important to stress FORPLAN's usefulness as an aid to understanding the nature of forest planning problems, not as a methodology to provide a set of numbers that may represent some optimal answer to a problem. It's major purpose is to provide insight into the behaviour of multiple resources and their interactions; which in turn can be used to guide the development of effective plans and decisions."

Behan's criticism of the U.S. Forest Service management is

322. Barber, K. H., and S. A. Rodman. 1990. FORPLAN: The marvelous toy. *J. of Forestry*. 88:5. pp. 26—30.

323. Behan, R.W. 1990. The RPA/NFMA: Solution to a nonexistent problem. *J. of Forestry*. 88:5. pp. 20—25.

324. Barber, K. H., and S. A. Rodman. 1990. FORPLAN: The marvelous toy. *J. of Forestry*. 88:5. pp. 26—30.

directed to the process used, not to the objective of multiple resources management.

The U.S. experience at multiple resource management can provide us with insight as to the problems to be avoided and certain fundamental elements that must be considered; such as, the identification of the production capabilities of all resources of the forest, the development of viable alternatives that consider all resources, a process for public involvement in plan development, and legislation that establishes the basis for multiple resource management (See Witness Statement of Zane G. Smith, Jr.). A most important factor in their management of all the forest resources is the recognition and study of problems in multiple resource management by government and educational institutions.³²⁵

One problem of the U.S. Forest Service system that could be avoided is the expense. Costs of the U.S. Forest Service planning process alone are estimated to be \$2 billion to date and \$200 million annually³²⁶ on an area of 28.5 million ha of federal forest land, an area equivalent to the 29.5 million hectares of productive forest land in Ontario. Thus, even if Ontario had the wealth of information and pecuniary resources available for use in management of the forests, an effective system acceptable to the public would need to be found to implement it. The reality is that Ontario has neither the detailed information available, and

325. **Johnson, James. E.** 1988. Managing North Central forests for non-timber values. Proceedings of the Fourth Society of American Foresters Region V Technical Conference. Duluth, Minnesota. 156 pp.

326. **Behan, R.W.** 1990. The RPA/NFMA: Solution to a nonexistent problem. *J. of Forestry*, 88:5. pp. 20—25.

probably not the financial resources, to research and collate all the necessary information. Consider the difficulty the OMNR has encountered in the relatively simple task of compiling silvicultural and allowable cut data. Information concerning the effects of forest management on other forest resources in Ontario are limited scientific studies or hypothetical evaluations of the process.³²⁷ The complexity of managing the forest resources requires the simplest, but most effective approach possible that will possibly enhance, but not harm the environment of the forest resources. Modified cutting and natural regeneration that can provide the simple but effective solution to the hydra of resource management for ecological purposes.

The primary pieces of knowledge missing, but that must be considered are:

- a). Lack of an adequate data base of all forest resources.
- b). Lack of studies of responses of the various biological resources of the forest to various harvesting techniques.

Information that is available and useful includes:

- a). Scientific studies for particular areas in the province.
- b). Scientific studies outside of the province that have established principles that may be applicable to the area of the

327. ESSA 1988. Effects monitoring for resource protection guidelines in Ontario. Environmental and Social Systems Analysts Inc., Toronto, Ontario. 226 pp.

undertaking.

c). Personnel experienced with particular results in certain areas. This knowledge may be limited to the alternatives, i.e. intensive silviculture, that have been used.

With critical information lacking, the manager must rely on the general principles established elsewhere and try to relate them to a particular area that lacks site specific information. Thus, detrimental effects of harvesting that have been proven to occur in other areas must be assumed to be likely in the area of the undertaking until it can be proven otherwise. To alleviate the detrimental effects, the methods that have been proven effective in other areas should be applied and monitored. The OMNR plans to take the step of monitoring the present type of harvesting, but is ignoring the lessons that may be learnt from areas outside of the province.

With the above in mind, there is still the problem of trying to apply the best treatment to an area that has an incomplete inventory of the resources of the forest. There are at least two possible alternatives:

a). Cease harvesting operations until the inventory (and) knowledge base for management are assembled. This is not an option that is really feasible and may be resisted by the industry even though they have a passionate concern for the long-term well being of northerners.

b). Apply known methods of harvesting and silvicultural techniques that will **limit the possible harm** to the area of the undertaking, combined with immediate measures to intensively survey areas being allocated for their current natural resource values.

The second method is more feasible than the first, and could be applied to the area of the undertaking by using a system of modified cuts and natural regeneration. Modified cuts should include small block cuts, strip cuts, shelterwood, and selection cutting. Area to be allocated for a five-year period should be thoroughly inventoried prior to the actual allocation in order to identify specific wildlife habitat and other important natural features. Areas for old growth and area dependent species should be identified throughout a management unit to allow for a continuity of development of these habitats over time. The interspersation of the various natural regeneration methods, using other than large clear cuts, would help ensure that areas will not lose their species and the diversity of those species.

Hunter³²⁸ identified three main factors that must be considered in developing a balanced design of a forest to maintain biological diversity. These three factors are:

a). A balanced age structure to provide a continuum of habitat for species that occupy the various age-classes (see Appendix I).

328. Hunter, M.L. 1990. Wildlife, forests, and forestry. Principles of managing forest for biological diversity. Prentice Hall, Englewood Cliffs, N.J. 370 pp. (See pp. 252—259).

This implies the development of a forest similar to a normal forest.

b). Spatial heterogeneity to provide the different sizes of area of an age-class to provide habitat for those species that are area dependent. In the boreal forests of Ontario, the majority of the operations favour those species that require large young age-class areas.

c). A variety of forest types provides the different habitat requirements for species necessary to ensure biological diversity.

A hypothetical arrangement of a forest designed by Hunter³²⁹ to meet these conditions is illustrated in Appendix II. The combination of large and small areas, balanced age-classes, and a variety of forests would provide the various habitat requirements of all species. In practice, the spatial arrangement and types of large and small cuts could be adjusted to take into account known information about an area. However, the hypothetical layout would provide a variety of habitat conditions for wildlife species over the variety of sites that may not be identified within the area.

329. **Hunter, M.L. 1990.** Wildlife, forests, and forestry. Principles of managing forest for biological diversity. Prentice Hall, Englewood Cliffs, N.J. 370 pp. (See pp. 256).

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Witness Statement No.5

WOOD SUPPLY AND ENVIRONMENTAL IMPACTS OF TIMBER

MANAGEMENT PART 1: MANAGEMENT ISSUES. / Benson,

**RESOURCE CENTRE
INST. FOR ENVIRON'L. STUDIES
UNIVERSITY OF TORONTO**



